USDA Forest Service
General Technical
Report INT-40

INTERMOUNTAIN FOREST
& RANGE EXPERIMENT
STATION
FOREST SERVICE
U.S. DEPARTMENT OF
AGRICULTURE



# MANUALLY CALCULATING FIRE-DANGER RATINGS — 1978 NATIONAL FIRE-DANGER RATING SYSTEM

Robert E. Burgan
Jack D. Cohen
John E. Deeming

## THE AUTHORS

Robert E. Burgan received his bachelor's degree in forest engineering in 1963 and his master's degree in forest fire control in 1966 from the University of Montana. From 1963 to 1969 he served on the timber management staff of the Union and Bear-Sleds Districts, Wallowa-Whitman National Forest. From 1969 to 1975 he was a research forester on the staff of the Institute of Pacific Islands Forestry, Honolulu, Hawaii. He transferred to the National Fire-Danger Rating research work unit at the Northern Forest Fire Laboratory, Missoula, Montana, in 1975.

Jack D. Cohen received his bachelor's degree in forest science from the University of Montana in 1973 and his master's degree in bioclimatology from Colorado State University in 1976. He did environmental air quality research before joining the National Fire-Danger Rating research work unit at the Northern Forest Fire Laboratory, Missoula, Montana, in May 1976.

John E. Deeming received his bachelor's degree in forestry from Utah State University in 1959. He has done graduate work in meteorology and biometeorology at the University of California at Los Angeles, the University of Hawaii, and Colorado State University. He served in the U.S. Air Force from 1960 to 1966 as a weather officer. In 1966 he joined the research staff at the Southern Forest Fire Laboratory, Macon, Georgia, to work on fire control methods. Mr. Deeming transferred to the Rocky Mountain Forest and Range Experiment Station, Fort Collins, Colorado, in 1970. His assignment was with the National Fire-Danger Rating System research work unit, developing the 1972 National Fire-Danger Rating System. In 1975 he assumed his present assignment at the Northern Forest Fire Laboratory, Missoula, Montana, as Leader of the National Fire-Danger Rating System research work unit.

USDA Forest Service
General Technical Report INT-40
October 1977

# MANUALLY CALCULATING FIRE-DANGER RATING — 1978 NATIONAL FIRE-DANGER RATING SYSTEM

Robert E. Burgan

Jack D. Cohen

John E. Deeming



INTERMOUNTAIN FOREST AND RANGE EXPERIMENT STATION
Forest Service
U.S. Department of Agriculture
Ogden, Utah 84401

# RESEARCH SUMMARY

This publication contains instructions for manually calculating the indexes and components of the 1978 National Fire-Danger Rating System (NFDRS). The procedures are explained with worked examples. Working sets of nomograms for the 20 NFDRS fuel models are not included. However, an order form for obtaining the needed nomograms is provided.

USDA Forest Service General Technical Report INT-39, The National Fire-Danger Rating System--1978 by John E. Deeming, Robert E. Burgan, and Jack D. Cohen, a companion publication, covers the NFDRS background, applications, and general principles of the system.

# CONTENTS

## ABBREVIATIONS

| | |
|---|---|
| BI | Burning index |
| ERC | Energy release component |
| FLI | Fire load index |
| IC | Ignition component |
| LAL | Lightning activity level |
| LOI | Lightning-caused fire occurrence index |
| LR | Lightning risk |
| MCOI | Man-caused fire occurrence index |
| MCR | Man-caused risk |
| NFDRS | National Fire-Danger Rating System |
| SC | Spread component |
| TL | Timelag |
| 1-h TL FM | 1-hour timelag fuel moisture content |
| 10-h TL FM | 10-hour timelag fuel moisture content |
| 100-h TL FM | 100-hour timelag fuel moisture content |
| 1,000-h TL FM | 1,000-hour timelag fuel moisture content |

## PREFACE

At the time of this writing, the 1972 version of the National Fire-Danger Rating System (Deeming and others 1972) is being used by all Federal and 35 State agencies charged with protecting forest and range land from wildfire. The 1972 System was implemented as a manual system utilizing tables for computing the indexes and components. An interactive, time-share computer program to do the computations (AFFIRMS) was developed during the period 1972 to 1974 and was made available for general use in early 1975 (Helfman and others 1975). In 1976, about one-third of the data processed through the NFDRS was done manually. Though AFFIRMS usage is expanding, there is a continuing need for a method to compute the ratings by hand. This publication covers the manual procedures for the 1978 update of the NFDRS (Deeming and others 1977).

The manual procedures of the 1978 NFDRS are more complex than those of the 1972 System. With the addition of the 1,000-hour timelag fuel class, separate occurrence indexes for man-caused and lightning-caused fires, and a more comprehensive ignition component, increased complexity was unavoidable. But there have been trade-offs. For instance, an office procedure for determining live fuel moisture contents has been substituted for the bothersome and usually unsatisfactory field transects.

These procedures have been thoroughly tested. If you conscientiously work through the examples and problem set, you will find that it will take only a little longer to compute the 1978 ratings than it took for the 1972 ratings.

# WHY NOMOGRAMS ARE USED

The 1978 NFDR indexes and components are calculated from nomograms that offer many advantages over the tables used for the 1972 NFDR System:

--Closer agreement between ratings calculated by the manual and computer systems.

--No need to arbitrarily establish class boundaries as when constructing tables.

--Better understanding of how factors such as temperature, relative humidity, windspeed, and slope affect indexes and components.

# DIFFERENCES BETWEEN MANUAL AND COMPUTER SYSTEMS

To keep manual calculations within reason, the manual system has been simplified over the computer system. Therefore, while index and component values calculated from the nomograms will be close to those produced by the computer, the results cannot be expected to match perfectly. The significant differences between the two systems are:

1. In the manual system, an assigned temperature is used for the computation of the 1-, 10-, 100-, and 1,000-h TL fuel moistures. The observed temperatures are used in the computer version.

2. The 24-hour average relative humidity is used to calculate the 24-hour average equilibrium moisture content (EMC) in the manual system. But in the computer system, two EMC values are calculated: one from the maximum temperature and and minimum relative humidity; the other from the minimum temperature and maximum relative humidity. These two EMC values are then weighted by the hours of daylight and darkness to obtain a final 24-hour average EMC value. As a result, the computer version will predict higher 100- and 1,000-h TL fuel moistures than the manual system when the days are shorter than the nights; and lower 100- and 1,000-h TL fuel moistures when the days are longer than the nights.

3. In the manual system, the 1-h TL fuel moisture and the herbaceous fuel moisture are combined into a single value called the *fine fuel moisture*. The fine fuel moisture is an equivalent moisture content that can be used for dead and living fine fuels. It produces the same spread and energy release component values as if a separate accounting were made of the live and dead fuel moistures. In the computer version, the 1-h TL and herbaceous fuel moistures are kept separate.

4. Whenever the maximum likely effect of any particular dead or live fuel component is small, it is excluded for simplification. For example, the G model contains live woody material, but the effect of this material on the energy release component is small. So it is not included in the ERC calculation. However, because the woody material does have a significant effect on the rate of spread, it is included in that calculation.

5. The manual system assumes an immediate greenup when the growing season starts. The computer version, on the other hand, allows a gradual greening over a time period dependent upon the climate class.

6. The 1,000-h TL fuel moisture is updated weekly in the manual system, while it is updated daily in the computer version. During rainy periods, the 1,000-h TL fuel moisture can change rapidly. In such cases, the manual system will tend to overrate fire danger until the 1,000-h TL fuel moisture is recalculated.

# TYPES OF NOMOGRAMS

Manual calculations utilize three general types of nomograms:

*Type 1.*--Those that are needed daily for most, if not all, fuel models:
- --1-h Timelag Fuel Moisture
- --10-h Timelag Fuel Moisture (computed)[1]
- --10-h Timelag Fuel Moisture (measured)
- --100-h Timelag Fuel Moisture
- --BNDRY Value (for the 1,000-h timelag fuel moisture)
- --Lightning Risk
- --Lightning Occurrence Index
- --Partial Risk
- --Man-Caused Risk
- --Man-Caused Fire Occurrence Index
- --Fire Load Index

*Type 2.*--Those used every *seventh* day for most, if not all, fuel models:
- --Change in 1,000-h Timelag Fuel Moisture
- --Woody Fuel Moisture
- --Herbaceous Fuel Moisture (perennial or annual)

*Type 3.*--Those used daily that are fuel model specific:
- --Fine Fuel Moisture
- --Ignition Component
- --Spread Component
- --Energy Release Component
- --Burning Index

---

[1] These are used (1) to estimate the current 10-h TL FM when fuel moisture sticks are not used and (2) for predicting the 10-h TL FM.

# OBTAINING A SET OF NOMOGRAMS FOR FIELD USE

The nomograms in this manual are for instructional purposes only. You must order a working set for the fuel model(s) you intend to use.

Order one set of type 1 and type 2 nomograms for each station, and one set of type 3 nomograms for each fuel model to be used. For example, assume you are ordering nomograms for use at two fire weather stations: Lone Pine and Rocky Knob. Fuel models L, H, and C are used at Lone Pine; while Rocky Knob uses fuel models L and R. Order two sets of type 1 and type 2 nomograms, two sets of type 3 nomograms for model L, and one set each of type 3 nomograms for models H, C, and R. Once again, types 1 and 2 nomograms are needed for all fuel models, while type 3 nomograms apply only to specific fuel models. *To obtain the nomogram sets, use the order form on page 51, which can be completed and pasted on a post card.* Fuel models are described in the general treatment of the 1978 NFDRS (Deeming and others 1977).

After you receive your nomograms, eliminate any type 1 or type 2 nomograms not required for the fuel model(s) you intend to use. Not all calculations are needed because not all fuel classes are found in every fuel model. Refer to table 1 to determine which, if any, of the nomograms can be discarded.

Those nomograms designated by an X in the column headed by the fuel model designator can be discarded. For example, the 100-h TL FM and the woody fuel moisture nomograms can be discarded when using fuel model A. (Fuel model A has no 100-h TL or live woody fuels.) Fuel models E, F, G, H, P, Q, R, S, and U are not shown in table 1 because they require all the type 1 and type 2 nomograms. Once you have collected the nomograms needed for your fuel model(s), place them in plastic document protectors in a looseleaf binder.

Table 1.--*Nomogram discards*

| Nomograms | Fuel model | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | A | B | C | D | F | I | J | K | L | N | O | T |
| 100-h TL fuel moisture | X | | X | X | | | | | X | X | | X |
| Woody fuel moisture | X | | | | | X | X | X | X | | | |
| Herb. fuel moisture | | X | | | X | X | X | X | | X | X | |

# USING THE NOMOGRAMS

Nomograms are a graphic method for solving the mathematical equations that are the basis of the NFDRS. There are three different forms of nomograms, depending on the number of variables or factors needed to solve a particular equation:

> *1-part nomograms.*--Solve equations with two input variables, such as A + B = C where A and B are known (inputs) and C is the desired answer.
>
> *2-part nomograms.*--Solve equations with three input variables, such as A × B ÷ C = D where A, B, and C are the inputs and D is the desired answer.
>
> *3- and 4-part nomograms.*--Solve equations with four or five input variables, such as A + B + C + D + E = F. These are combinations of 1- and 2-part nomograms. An intermediate result from one nomogram is carried forward and used in a second nomogram.

For example, a 2-part and a 1-part nomogram may be combined to produce a 3-part nomogram. The first two steps may solve an equation of the form A + B + C = X, where A, B, and C are inputs and X is an intermediate value. This intermediate value is carried forward to a second nomogram to solve an equation of the type X + D = E, where X and D are the known values and E is the final answer.

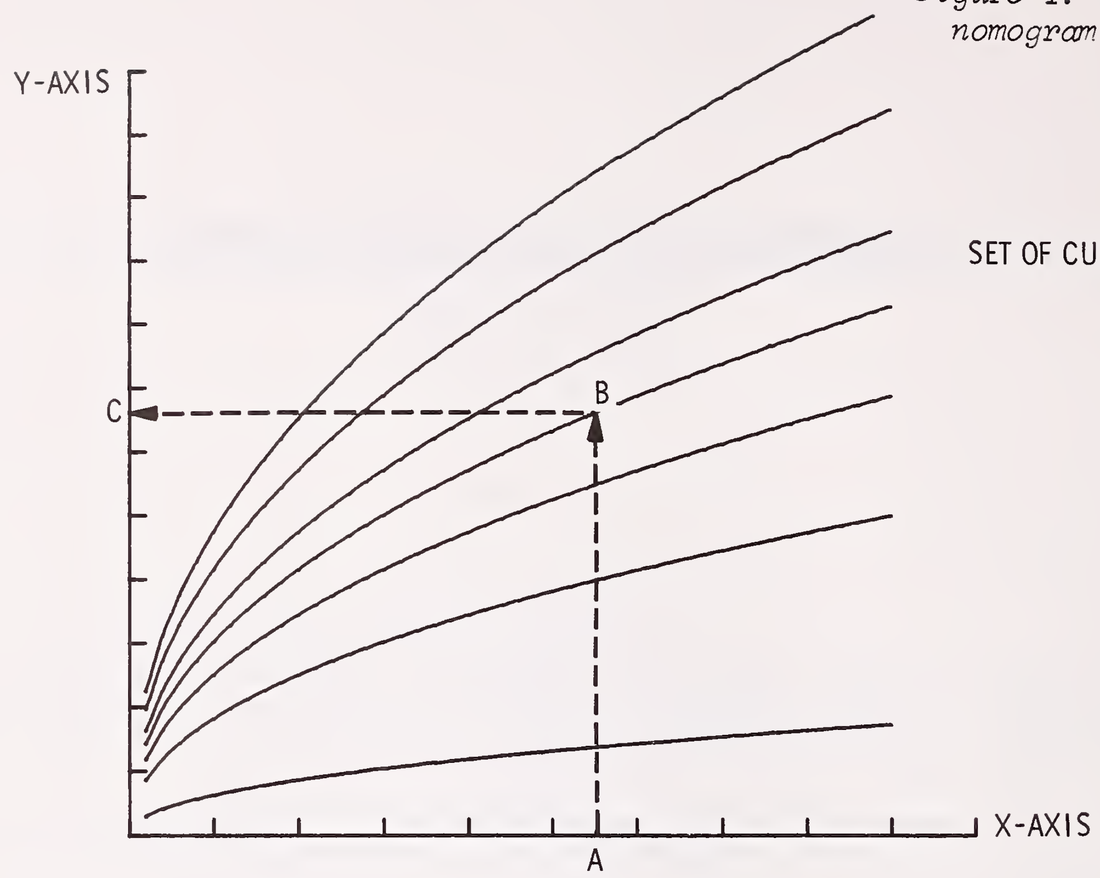
The nomograms will be introduced by reviewing procedures for reading each form of nomogram.

The 1-part nomogram (fig. 1) consists of the x-axis, the y-axis, and one or several curves or straight lines.

To use the nomogram:

1. Locate the value of the first variable, A, on the x-axis.
2. Draw an imaginary line vertically to point B on the curve corresponding to the value of the second variable.
3. Extend a line horizontally to the left from B to C on the y-axis.
4. The desired answer is found at C.

*Figure 1.--1-part nomogram.*



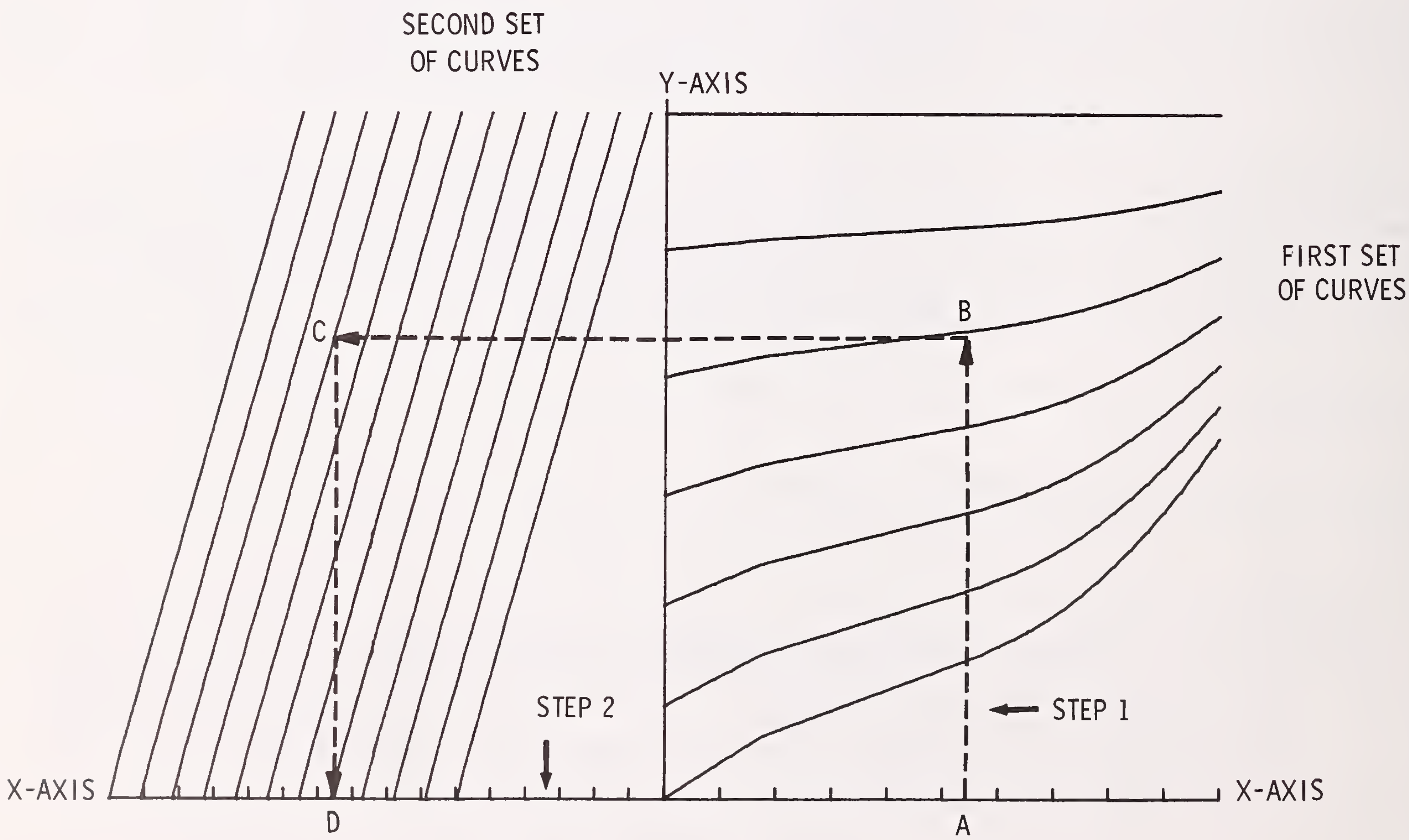




*Figure 2.--2-part nomogram.*

The 2-part nomogram (fig. 2) consists of the y-axis, the x-axis (extends left *and* right of its intersection with y-axis), and two families of curves or straight lines.

To use the nomogram:

1. Locate the value of the first variable, A, on the x-axis.
2. Draw an imaginary vertical line to point B on the curve corresponding to the value of the second variable.
3. Extend a line horizontally to the left from B to point C on the curve that represents the value of the third variable.
4. Extend a line vertically down from C to D, on the x-axis.
5. The desired answer is found at point D.

When constructing the nomograms, a standard procedure was set that would always result in reading an answer from either the y-axis or the left side of the x-axis. However, some computations require more than two steps. In such cases, an intermediate value must be brought forward for entry into a second nomogram.

The general form of the 3-part nomogram is shown in figure 3.

Steps 1 and 2 are carried out exactly as described for the 2-part nomogram, and step 3 is carried out exactly as described for the 1-part nomogram. But X, the value from step 2, must be brought forward for step 3 in the 1-part nomogram.

The 3-part nomogram does not always look exactly as shown. In some cases, the 1-part nomogram is first and the 2-part nomogram second.

In the construction of multiple-part nomograms, the intermediate value X can be entered on the x-axis or elsewhere in the body of the nomogram. In the sample 3-part nomogram, the intermediate value could have been entered at B, C, or D. You need only be aware that the intermediate value will not always be entered on the x-axis.

The sample 4-part nomogram (fig. 4) illustrates how this can be done. The 4-part nomogram is solved as though you were doing two 2-part nomograms in sequence. For illustrative purposes, the intermediate value (X) is one of the curves on the right side of the second nomogram. These procedures are extended to solve 5 or more part nomograms.

In the illustrations presented so far, the values of the variables have always been located exactly on a curve or line. When real data are used, they will seldom fall exactly on one of the curves of the nomogram. In such a situation, interpolation must be used. Example:

Given: 1-h TL FM = 7 percent
Dry bulb temperature = 80° F (27° C)
Spread component = 4

In this sample ignition component nomogram (fig. 5), start with the 1-h TL FM at 7 percent; go up to the point halfway between the 70° and 90° F temperature curves. Next, go left to a point one-third of the way between the 3 and 6 spread component curves. The ignition component is read directly below this point on the x-axis--20.

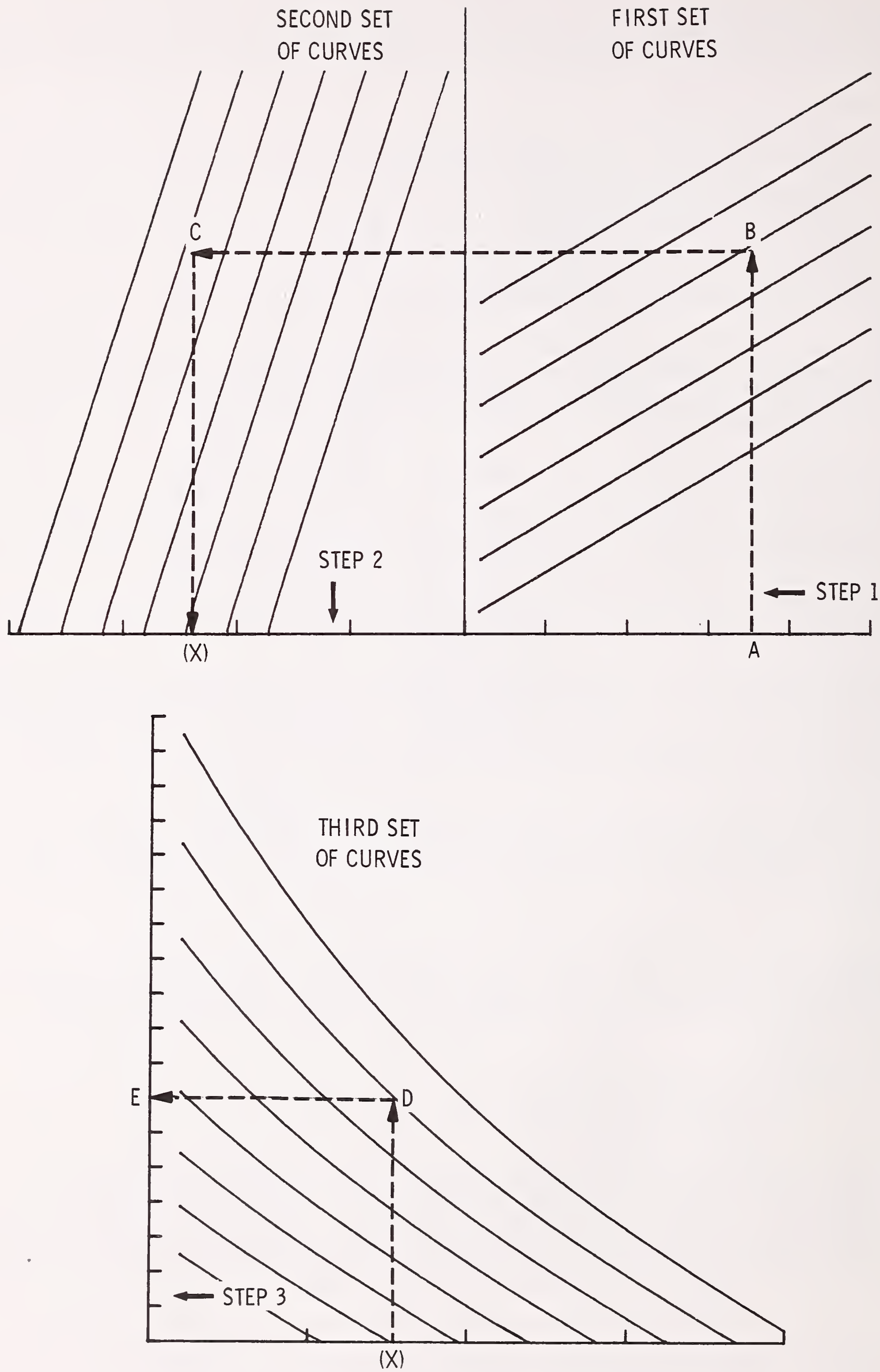



*Figure 3.--3-part nomogram.*

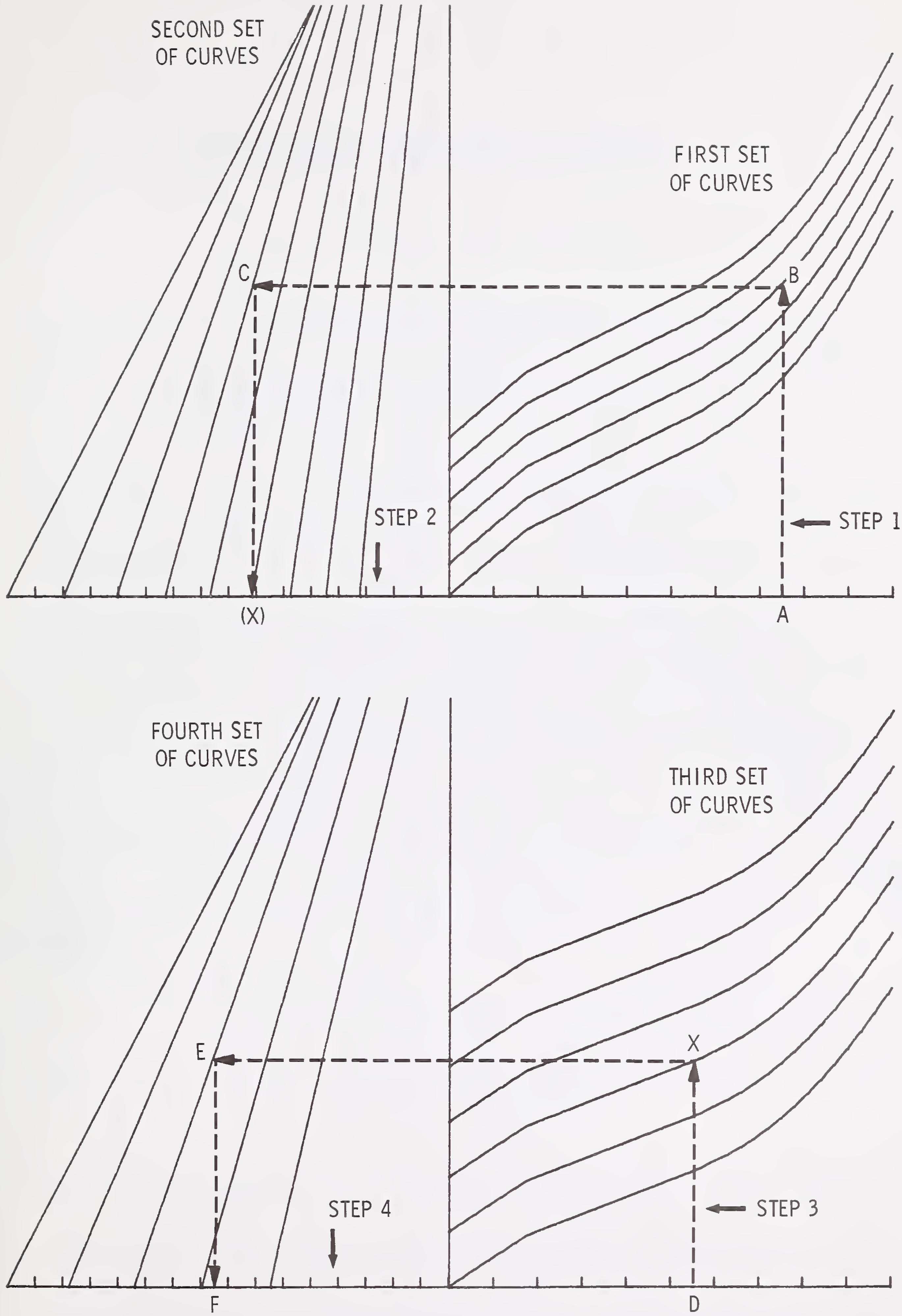



*Figure 4.--4-part nomogram.*

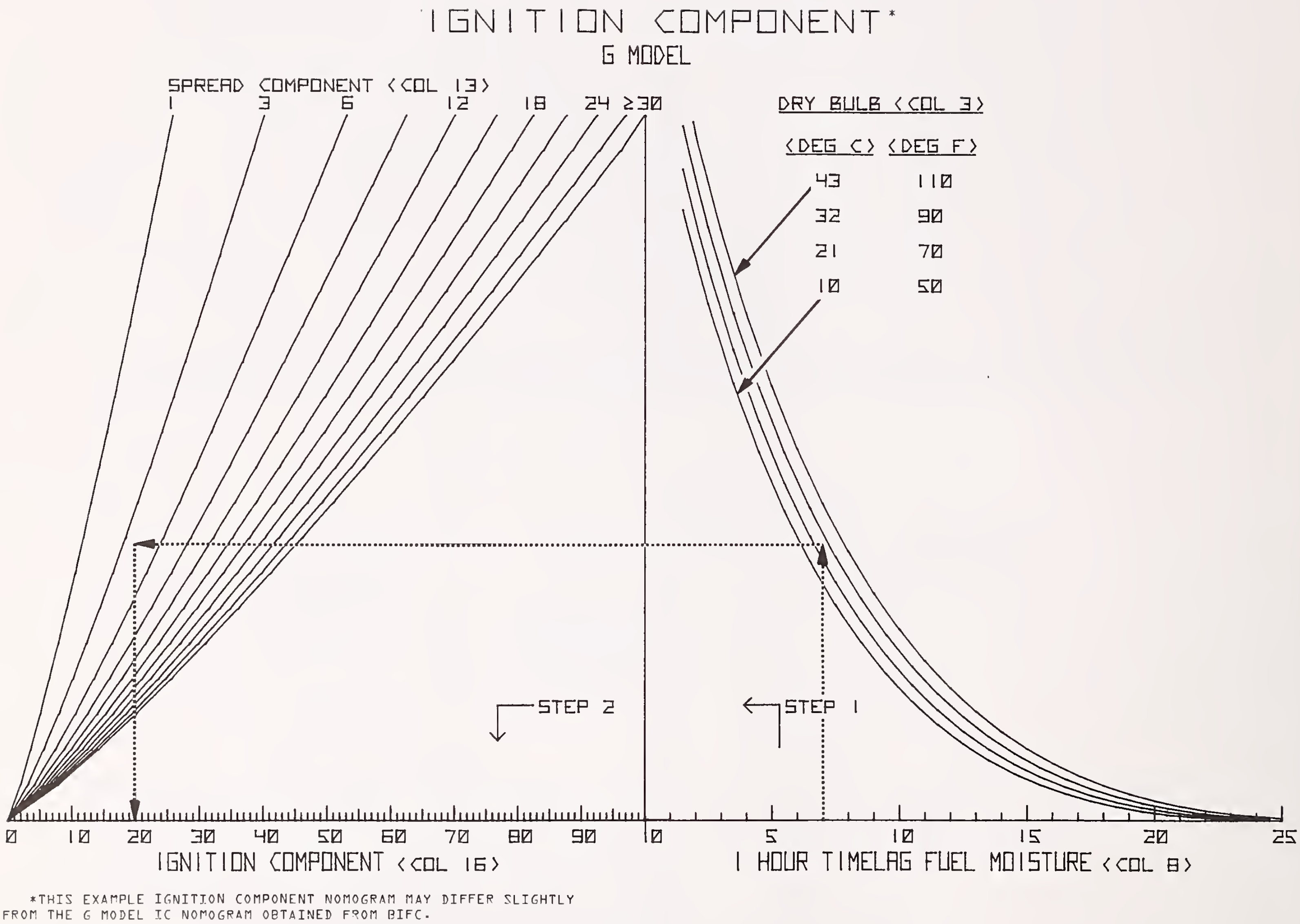



*Figure 5.--An example computation of the ignition component illustrating interpolation procedures.*

# SPECIAL INSTRUCTIONS

The following special instructions and rules are keyed to specific computation steps (nomograms). The steps correspond to the sequence followed in calculating the fire-danger ratings. The column numbers on the nomograms refer to the recording-computation form (10-Day Fire Danger and Fire Weather Record).

*100-h TL Fuel Moisture (Column 36)*

--If yesterday's 100-h TL FM exceeds 44 percent, use 44 percent.

--Record to the nearest whole percent.

*Today's 1,000-h Boundary Value (Column 37)*

--Record to the nearest whole percent.

--Average every seventh day and enter in column 38.

*Change in 1,000-h TL Fuel Moisture (Column 39)*

--Use this nomogram every seventh day.

--Be careful to note whether the change in the 1,000-h TL FM is (+) or (-) and record with the proper sign to the nearest whole percent.

--Add this value to the 1,000-h TL FM at the beginning of the 7-day period to obtain the current 1,000-h TL FM and record the answer in column 40.

*Live Fuel Model Nomograms*

Three nomograms are available to calculate the moisture contents of the three classes of live fuels: PERENNIAL HERBS AND FORBS, ANNUAL HERBS AND FORBS, and WOODY SHRUBS. General instructions follow. Differences are addressed in the instructions for specific nomograms.

*General Instructions*

A. Use either the nomogram for the annual herbs and forbs, or the nomogram for the perennial herbs and forbs. You *cannot* use a combination of the two.

B. The 1,000-h TL FM is used to calculate the woody fuel moisture, but the moisture content of herbaceous fuels depends on the X1000 moisture value.

C. The X1000 moisture value is set equal to the 1,000-h TL FM at greenup in the spring, or at midseason flush, as sometimes occurs in the desert areas.

D. Greenup is specified by the user. Two criteria should be adhered to: (1) Wait until the greening process is well established; and (2) declare greenup at the beginning of a 7-day cycle used to calculate the 1,000-h TL FM.

E. The live herbaceous fuel moistures are calculated from greenup until curing is complete either because the moisture content of the herbaceous fuels decreases to 30 percent or a freeze causes curing. From that time until the next greenup, that moisture content equals the 1-h TL FM.

F. The woody fuel moisture nomogram is used from greenup until the plants become dormant, usually the result of cold weather. After a freeze, the woody fuel moisture is set to the lesser of (1) the last value computed, or (2) the pregreen woody fuel moisture. Select the appropriate pregreen woody moisture for your climate class from the following:

| *Climate class* | *Pregreen woody fuel moisture (Percent)* |
|---|---|
| 1 | 50 |
| 2 | 60 |
| 3 | 70 |
| 4 | 80 |

This value is to be used until the next greenup. For example, you are using climate class 3 and a hard freeze occurs on October 10. If the woody fuel moisture was computed as 90 percent on October 9, decrease it to 70 percent on October 10. Use 70 percent for the remainder of the fire season. But if the computed woody fuel moisture was 60 percent on October 9, use 60 percent for the remainder of the fire season.

*Woody Fuel Moisture (Column 41)*

A. *Prior to spring greenup.*--Between the time fire weather observations are started in the spring and greenup, use the pregreen woody fuel moisture corresponding to your climate class.

B. *Computing woody fuel moistures.*--Begin computing woody fuel moistures the day you specify greenup. Use the current 1,000-h TL FM. Every seventh day thereafter, compute and record the woody fuel moisture to the nearest 10 percent. Note that the maximum fuel moisture is 200 percent; the minimum, 50 percent.

*Herb. Fuel Moisture (Column 43)*

A. *Prior to spring greenup.*--Make the following entries in the 10-Day Fire Danger and Fire Weather Record:

1. Record "C" (cured) for Herb. Veg. Condition (column 9).
2. Use the 1-h TL FM (column 8) for Herb. Fuel Moisture. Skip to the 10-h TL FM calculation.

B. *At greenup (spring or midseason flush).*--On the day you specify greenup (it should be at the beginning of a 7-day cycle for the 1,000-h TL FM calculation), make the following entries on the 10-Day Fire Danger and Fire Weather Record:

1. Enter "G" (green) for Herb. Veg. Condition (column 9) on that dateline and that dateline *only*.

2. Set the value of X1000 (column 42) equal to the 1,000-h TL FM value on that dateline (Column 40).

Make the initial Herb. Fuel Moisture calculation using the appropriate nomogram.

C. *After greenup.*--Column 9 (Herb. Veg. Condition) should be left blank until a second or third flush of new growth is observed or until these plants cure. Curing can occur through natural drying or because of a freeze. If curing occurs because of a freeze, enter an "F" in column 9; if it occurs through drying, enter a "C." If a "C" or an "F" has been recorded or the Herb. Fuel Moisture is less than 30 percent, use the 1-h TL FM for the Herb. Fuel Moisture and the Fine Fuel Moisture for the remainder of the season or until the next greenup.

*10-h TL Fuel Moisture (Column 7)*

--If snow or ice covers the 1/2-inch fuel moisture sticks, remove it. If it is raining at basic observation time, shake the excess water from the sticks. Weigh the sticks to the nearest gram and record this value in column 6. Use the nomogram to correct the reading for stick age. Record this 10-h TL FM value to the nearest percent.

--If the 1/2-inch fuel moisture sticks are not used, compute using the procedure in appendix B.

*When It Is Raining At Basic Observation Time*

--If it is raining (state of weather codes 5, 6, or 7), or if there is snow or ice on the ground, make the following entries on the 10-Day Fire Danger and Fire Weather Record:

| Item | Entry | Column |
|---|---|---|
| 1-h TL Fuel Moisture | 30+ | 8 |
| Herb. Veg. Condition | 98 | 9 |
| Fine Fuel Moisture | 30+ | 10 |
| Spread Component | 0 | 13 |
| Energy Release Component | 0 | 14 |
| Burning Index | 0 | 15 |
| Ignition Component | 0 | 16 |
| Lightning Occurrence Index | 0 | 18 |
| Man-Caused Occurrence Index | 0 | 20 |
| Fire Load Index | 0 | 21 |

*1-h TL Fuel Moisture (Column 8)*

--If the 10-h TL FM has not been obtained by weighing fuel sticks, compute it by the optional method in appendix B.

--Record the 1-h TL FM to the nearest whole percent.

*Fine Fuel Moisture (Column 10)*

--If the Herb. Veg. Condition (column 9) is cured (C) or cured by freezing (F), use the value from column 8 (1-h TL FM) for the Fine Fuel Moisture.

--If the 1-h TL FM is high enough that it is impossible to intersect the appropriate Herb. Fuel Moisture curve in step 1 (the correct value lies too far to the right on the x-axis), use the highest possible value for the Fine Fuel Moisture, as indicated on the left half of the x-axis.

Example: When using the G fuel model, if the 1-h TL FM is 22 percent and the Herb. Fuel Moisture is higher than about 140 percent, no intersection exists. In such cases, the Fine Fuel Moisture should be recorded as 25 percent.

--At no time should the Fine Fuel Moisture be less than the 1-h TL Fuel Moisture (column 8).

--Record Fine Fuel Moisture to the nearest whole percent.

*Spread Component (Column 13)*

--The Wind Slope Factor is not recorded on the computation form, but it is carried forward to step 3 (second Spread Component nomogram).

--Note that the windspeed can be entered in miles per hour using the upper scale on the x-axis or in kilometers per hour using the lower scale.

*Energy Release Component (Column 14)*

--The value called "B" from step 2 is carried forward to step 3 (second Energy Release Component nomogram).

*Burning Index (Column 15)*

--None.

*Ignition Component (Column 16)*

--The IC equals zero when the SC is zero.

--In step 1 the dry-bulb temperature can be entered in degrees Fahrenheit or in degrees Centigrade.

*Lightning Risk (Column 17)*

--If the Lightning Activity Level (column 35) is 1, record the LR and the LOI (column 18) as zero. Skip to the calculation of MCR.

--If the LAL is 6, record 100 for the LR and LOI and skip to the MCR calculation.

*Lightning-Caused Fire Occurrence Index (Column 18)*

--If the LAL is 1, the LOI is zero; if the LAL is 6, the LOI is 100 (Deeming and others 1977).

*Man-Caused Risk (Column 19)*

--None (Deeming and others 1977).

*Man-Caused Fire Occurrence Index (Column 20)*

--Two nomograms are provided; one for use when the IC is less than or equal to 30, the other when the IC is greater than 30 percent.

*Fire Load Index (Column 21)*

--If the BI is greater than 140, use 140; if the sum of the LOI and MCOI is greater than 100, use 100.

# COMPUTATIONAL PROCEDURES: A WORKED EXAMPLE AND EXERCISE

A complete set of nomograms for fuel model G and two sample 10-Day Fire Danger and Fire Weather Record forms are provided (pages 16-41). The solutions of the fuel moistures, components, and indexes for the first day are shown with dashed lines on the nomograms. Work through the example for the first day to familiarize yourself with the procedures. Use the remaining 9 days of weather data for practice, recording your answers on the first form. Check your results against the entries on the second form. Because of rounding differences, you are correct if your answers are within ±1 point of those on the answer sheet.

You need only compute the man-caused risk for July 3 and 4. The completed MCR worksheets for July 1 and 2 and the partially completed MCR worksheets for July 3 and 4 are provided.

To get started, assume the following conditions for June 30, 1975:

--Fuel model = G
--Slope class = 3
--Lightning risk scaling factor (LRSF) = 0.85
--Man-caused risk scaling factor (MRSF) = 0.18
--100-h TL FM = 17 percent
--1,000-h TL FM = 14 percent
--X1000 = 14 percent
--Herbaceous vegetation condition (column 9). No midseason flush of growth occurs during this sample exercise. Leave blank.
--Age of fuel moisture sticks = 3 months
--Yesterday's lightning fire occurrence index = 50

Assume the previous 7-day period for calculating the 1,000 h TL FM ended on July 1. The next 7-day period starts July 2 and ends July 8. After completing this exercise, use the form in the back of this manual to order a working set of nomograms for each fuel model you will use.

10 DAY
FIRE DANGER AND FIRE
WEATHER RECORD

| Agency | Unit | Station Name | Station Number |
|---|---|---|---|
| FOREST SERVICE | LIBBY DISTRICT | LIBBY | 240107 |

| Station Elevation | Fuel Model | ~~Annual or~~ Perennial | Slope Class | Climate Class | Basic Obs Time (LST) | Period of Record (Month,Day,Year) From | To |
|---|---|---|---|---|---|---|---|
| 2070 | G | P | 3 | 3 | 1400 | 7/1/75 | 7/10/75 |

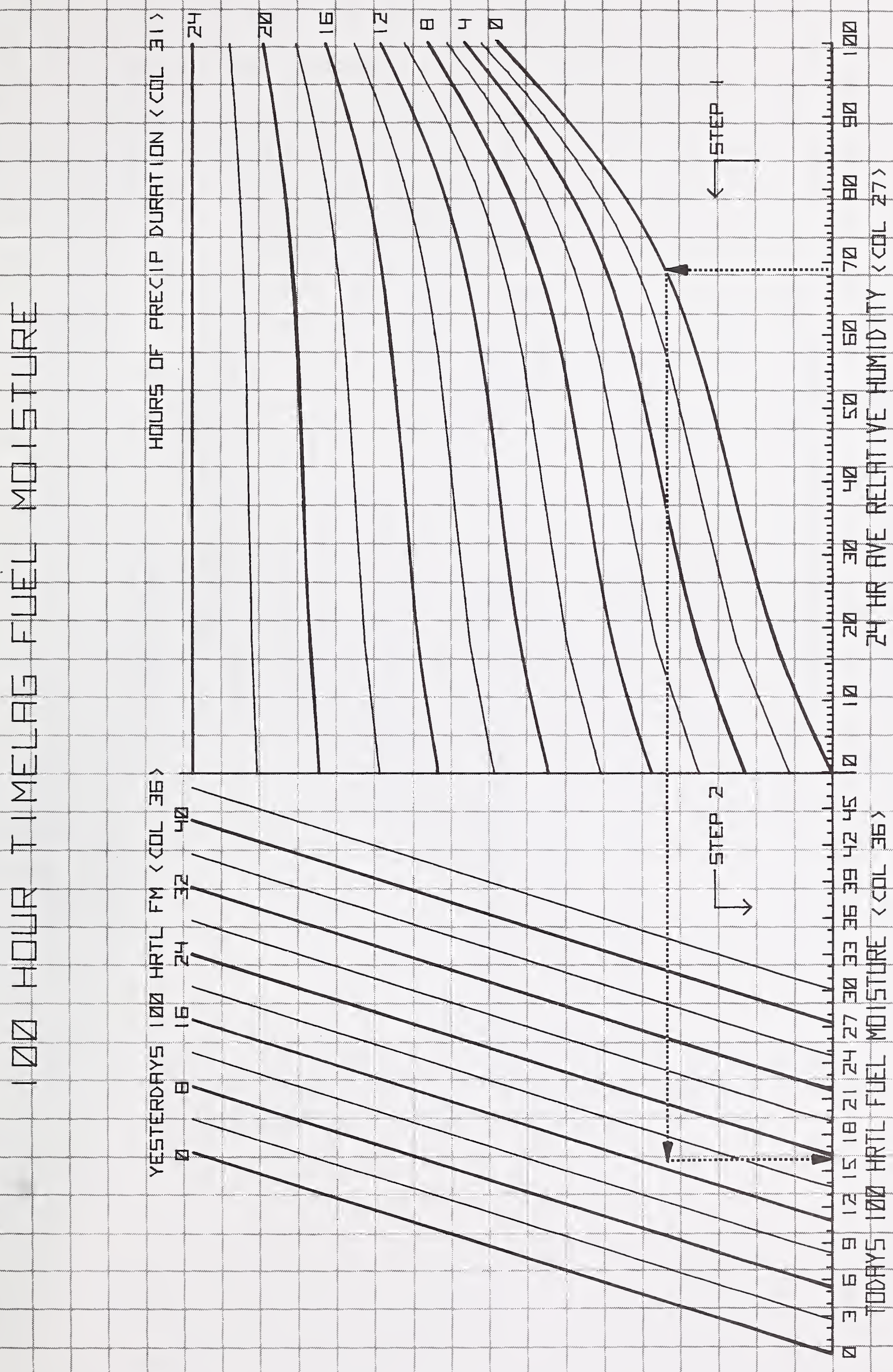
Observer

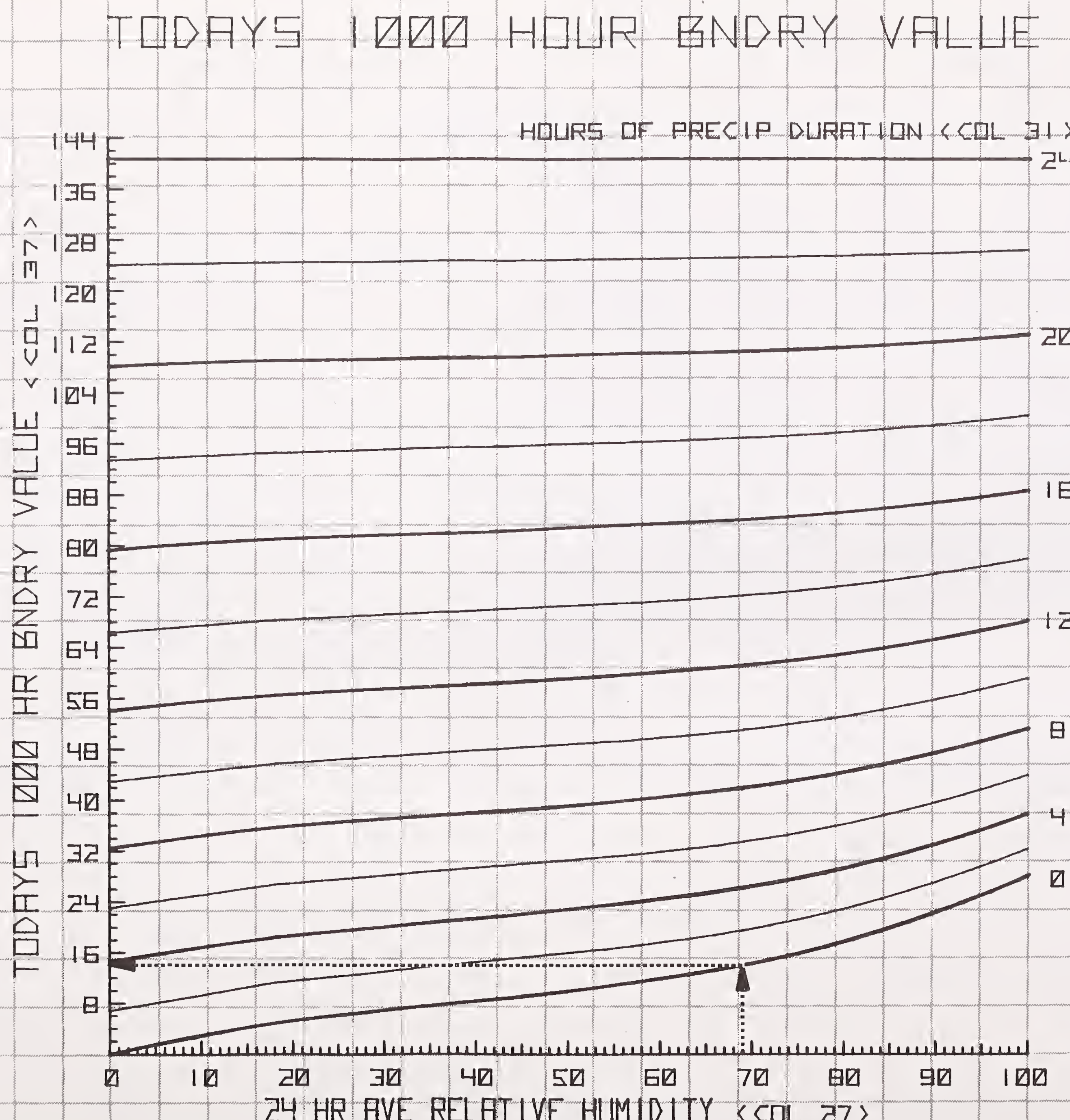
Checked By

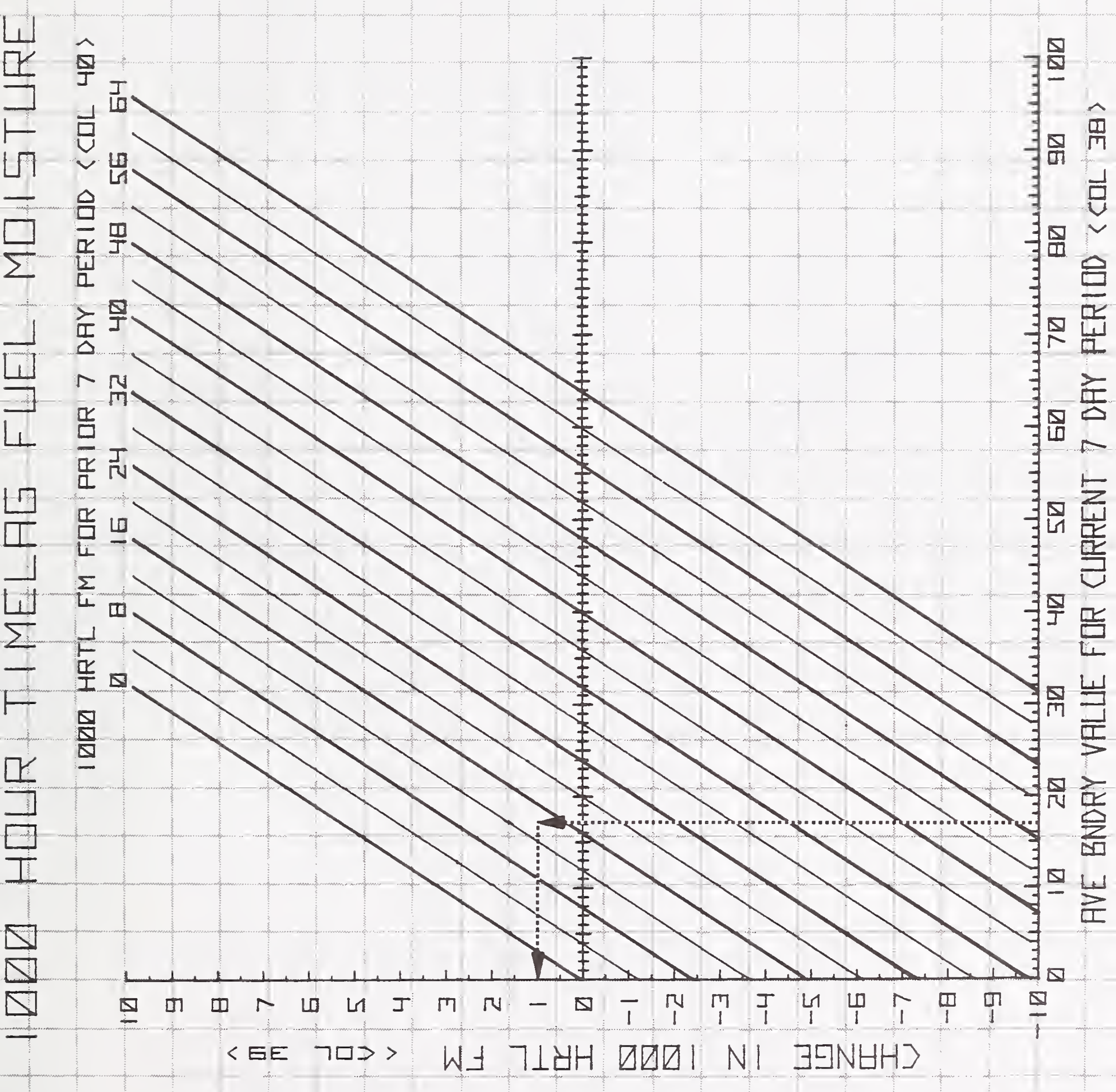
| Day of Month | State of Weather | Temperature: Dry Bulb | Temperature: Wet Bulb | Relative Humidity | Observed Fuel Sticks | 10-Hr TL Fuel Moisture | 1-Hr TL Fuel Moisture | Herb. Veg. Condition | Fine Fuel Moisture | Wind: Direc-tion | Wind: Speed | Burning Index: Spread Component | Energy Release Component | | Ignition Component | Occurrence Indexes: Lightning Risk | Lightning Occurrence Index | Man-caused Risk | Man-caused Occurrence Index | Fire Load Index | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | |
| 1 | 1 | 79 | | 39 | 10 | 13 | 7 | | 13 | | 2 | 4 | 33 | 28 | 20 | 11 | 18 | 10 | 2 | 24 | ½" FM STICKS |
| 2 | 2 | 81 | | 32 | 7 | | | | | | 2 | | | | | | | 19 | | | ARE 3 MOS. OLD |
| 3 | 3 | 69 | | 34 | 8 | | | | | | 2 | | | | | | | | | | |
| 4 | 6 | 55 | | 94 | 21 | | | 98 | | | 1 | | | | | | | | | | |
| 5 | 3 | 61 | | 69 | 28 | | | | | | 1 | | | | | | | 20 | | | |
| 6 | 3 | 64 | | 53 | 19 | | | | | | 1 | | | | | | | 13 | | | |
| 7 | 1 | 72 | | 40 | 11 | | | | | | 4 | | | | | | | 15 | | | |
| 8 | 0 | 78 | | 41 | 9 | | | | | | 2 | | | | | | | 12 | | | |
| 9 | 6 | 52 | | 100 | 21 | | | 98 | | | 2 | | | | | | | 23 | | | |
| 0 | 3 | 57 | | 67 | 26 | | | | | | 3 | | | | | | | 25 | | | |
| 31 | | | | | | | | | | | | | | | | | | | | | |

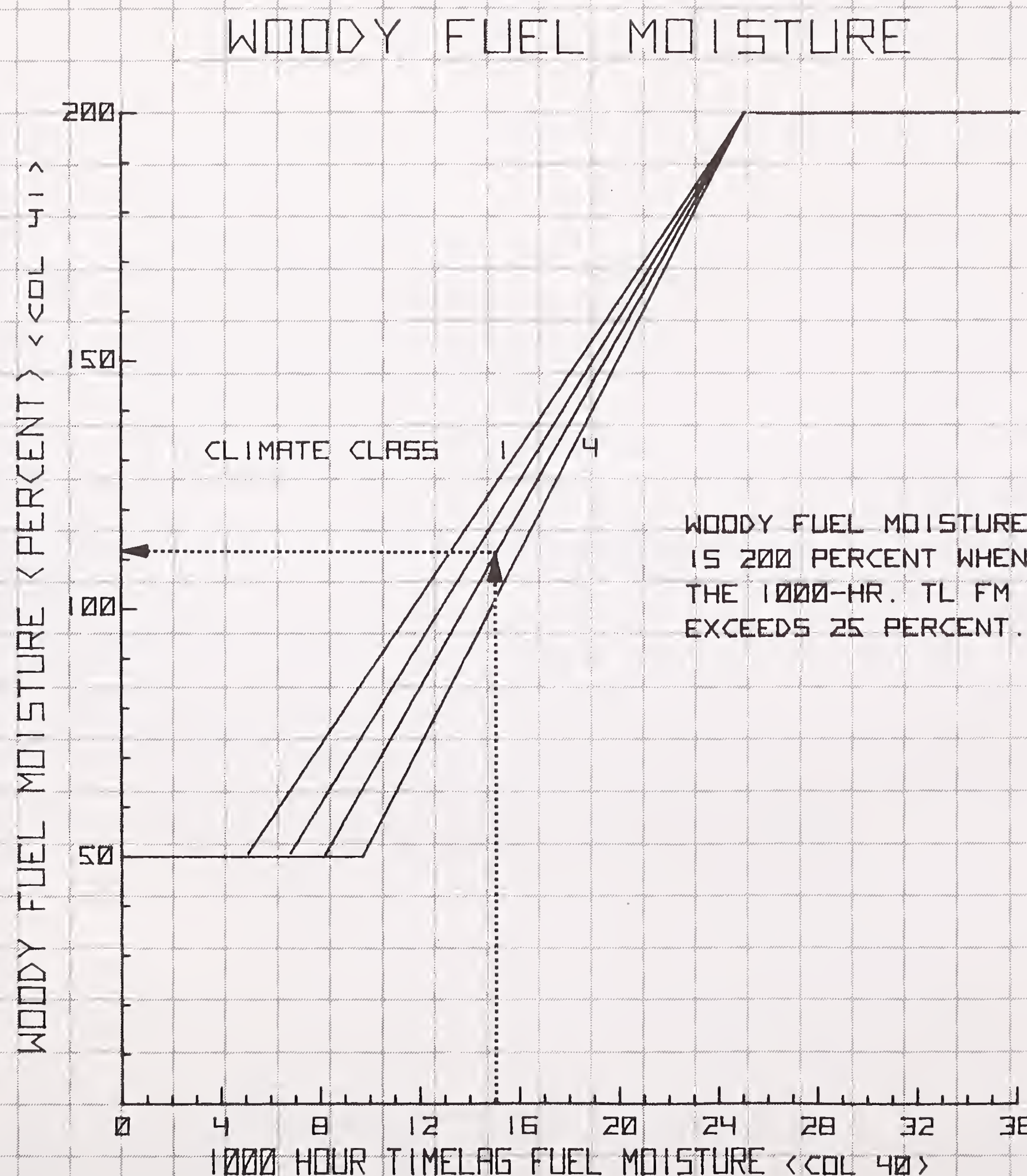
Daily (24 Hour) Data

| Day of Month | Temperature: Maximum | Temperature: Minimum | Relative Humidities: Maximum | Relative Humidities: Minimum | Relative Humidities: Average | Precipitation: Kind | Precipitation: Began | Precipitation: Ended | Precipitation: Duration | Precipitation: Amount | Lightning: Began | Lightning: Ended | Lightning: Activity Level | 100-Hr TL Fuel Moisture | 1000-Hr TL Fuel Moisture: Today's 1000-Hr Bndry Value | Average 7 Day Bndry Value | Change 1000-Hr Fuel Moisture | 1000-Hr TL Fuel Moisture | Living Fuel Moistures: Woody Fuel Moisture | X1000 Moisture Value | Herb Fuel Moisture | A | B | C | D |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 | 31 | 32 | 33 | 34 | 35 | 36 | 37 | 38 | 39 | 40 | 41 | 42 | 43 | A | B | C | D |
| 1 | 79 | 44 | 99 | 39 | 69 | | | | 0 | | | | 2 | 16 | 14 | 17 | +1 | 15 | 110 | 14 | 100 | | | | |
| 2 | 82 | 40 | 90 | 22 | 56 | | | | 0 | | | | 1 | | | | | | | | | | | | |
| 3 | 84 | 44 | 99 | 20 | 60 | | | | 0 | | | | 1 | | | | | | | | | | | | |
| 4 | 69 | 48 | 99 | 30 | 65 | 5 | 0500 | 1300 | 8 | .16 | | | 1 | | | | | | | | | | | | |
| 5 | 61 | 45 | 99 | 69 | 84 | 5 | 0200 | 1200 | 10 | .32 | | | 1 | | | | | | | | | | | | |
| 6 | 66 | 46 | 99 | 52 | 76 | 5 | 1600 | 1800 | 2 | .05 | | | 1 | | | | | | | | | | | | |
| 7 | 72 | 47 | 99 | 40 | 70 | 6 | 0800 | 0900 | 1 | .04 | | | 1 | | | | | | | | | | | | |
| 8 | 78 | 45 | 99 | 40 | 70 | | | | 0 | | | | 4 | | | | | | | | | | | | |
| 9 | 85 | 52 | 99 | 32 | 66 | 6 | 1300 | 1800 | 5 | .29 | | | 2 | | | | | | | | | | | | |
| 0 | 76 | 42 | 99 | 67 | 83 | 6 | 1600 | 1800 | 2 | .12 | | | 2 | | | | | | | | | | | | |
| 31 | | | | | | | | | | | | | | | | | | | | | | | | | |

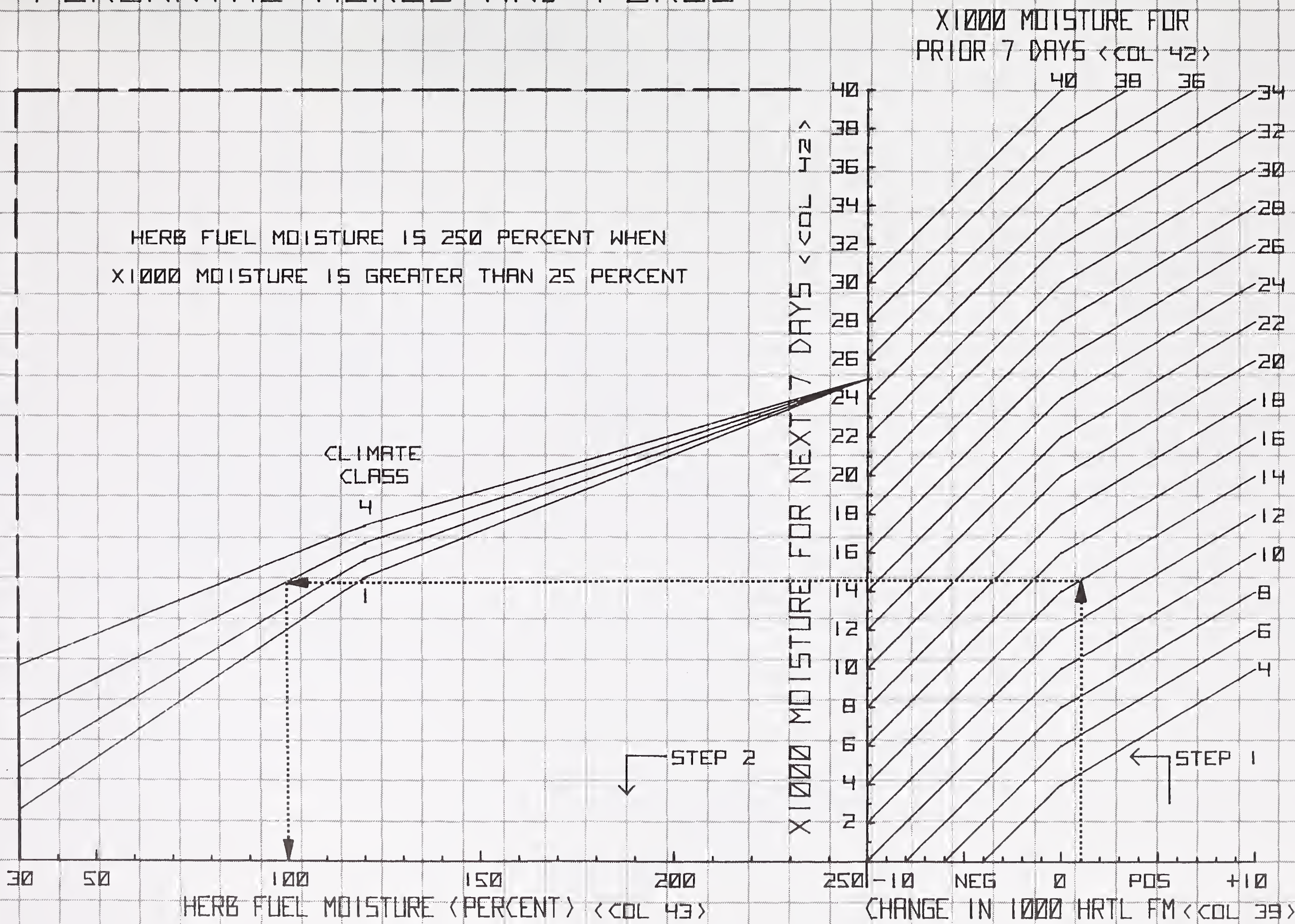

100 HOUR TIMELAG FUEL MOISTURE
HOURS OF PRECIP DURATION <COL 31>
24
20
16
12
8
4
0
STEP 1
24 HR AVE RELATIVE HUMIDITY <COL 27>
0 10 20 30 40 50 60 70 80 90 100
YESTERDAYS 100 HRTL FM <COL 36>
0 8 16 24 32 40
STEP 2
TODAYS 100 HRTL FUEL MOISTURE <COL 36>
0 3 6 9 12 15 18 21 24 27 30 33 36 39 42 45

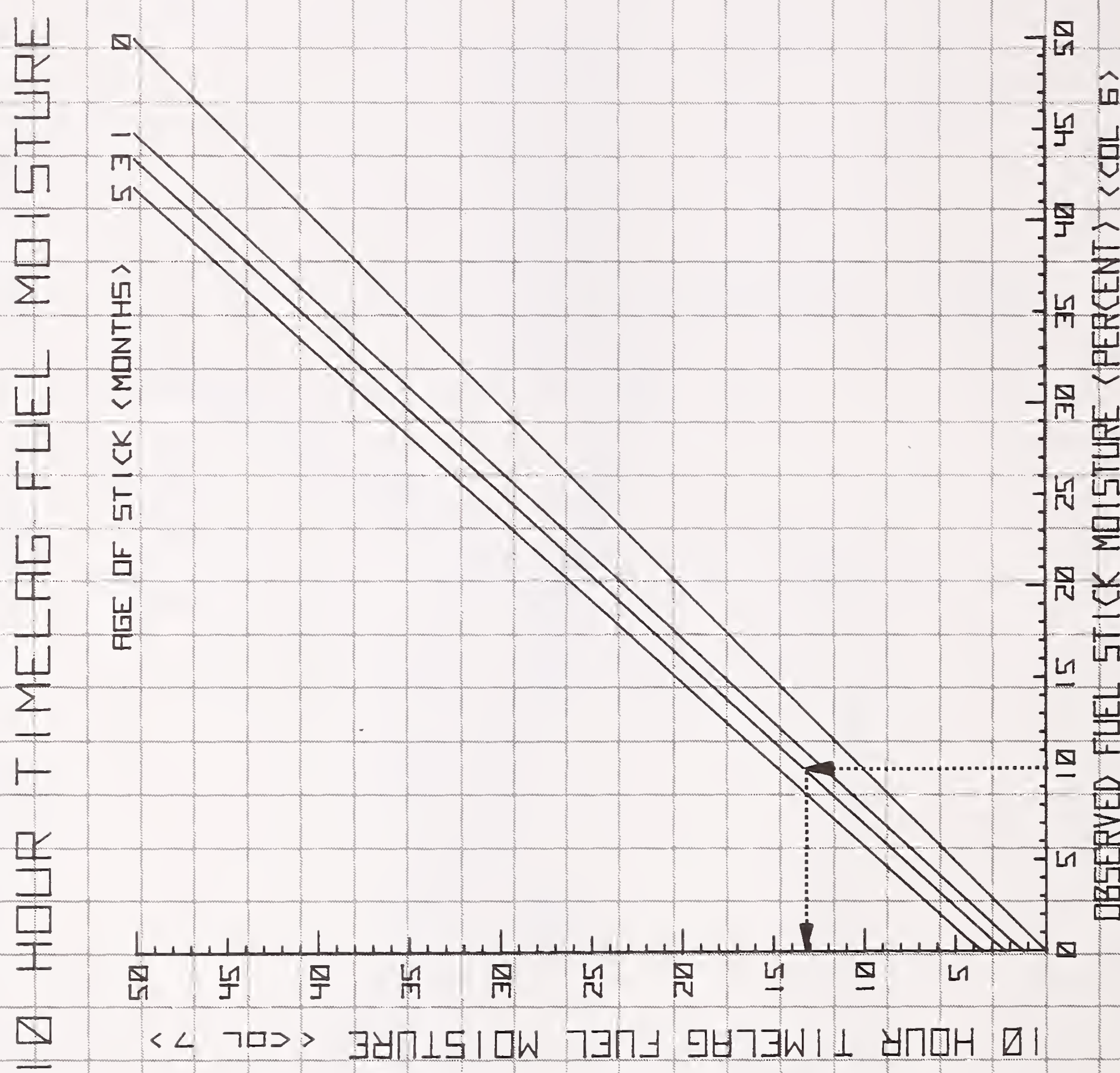

TODAYS 1000 HOUR BNDRY VALUE
HOURS OF PRECIP DURATION <COL 31>
24
20
16
12
8
4
0
TODAYS 1000 HR BNDRY VALUE <COL 37>
144
136
128
120
112
104
96
88
80
72
64
56
48
40
32
24
16
8
0
10
20
30
40
50
60
70
80
90
100
24 HR AVE RELATIVE HUMIDITY <COL 27>

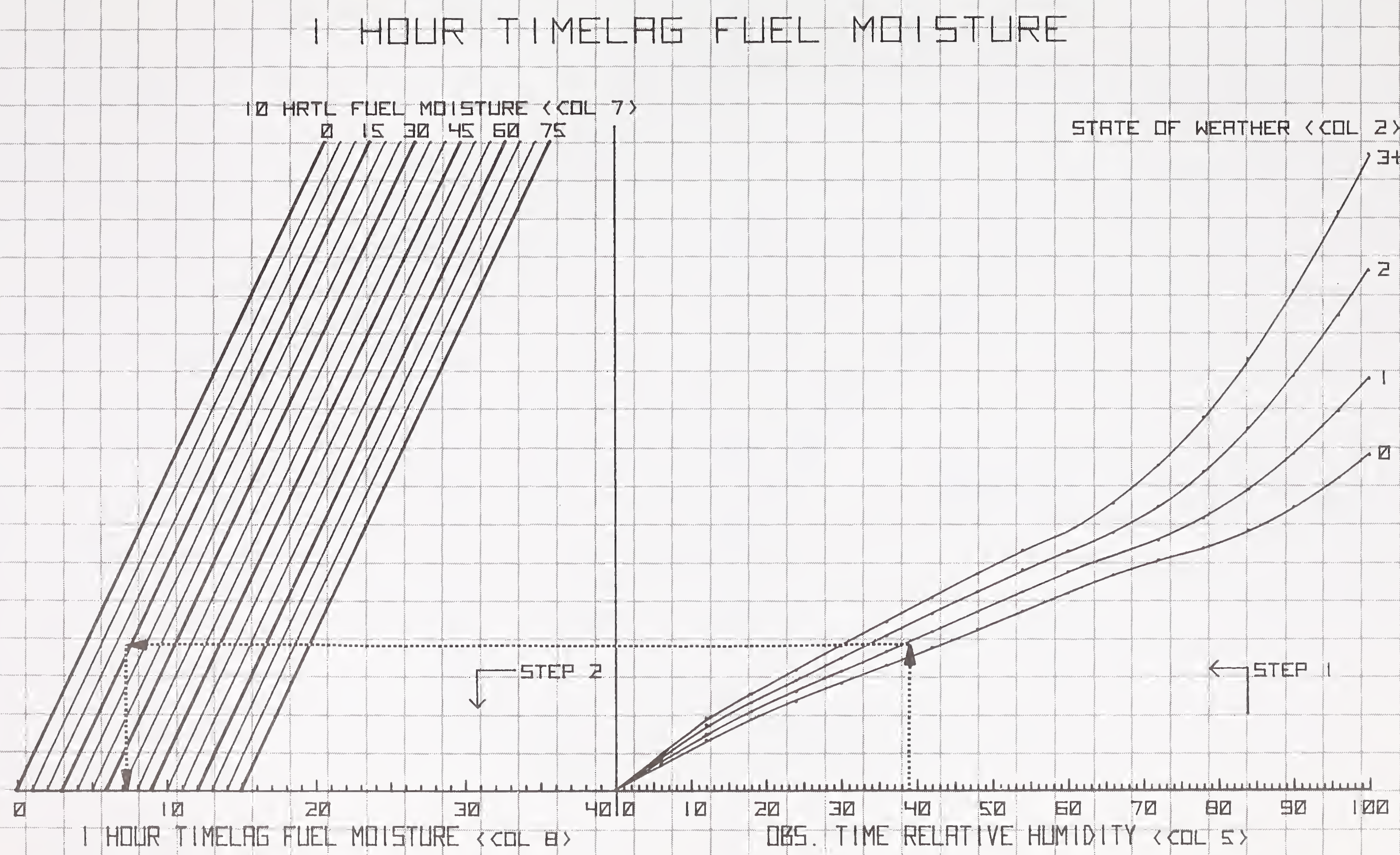

1000 HOUR TIMELAG FUEL MOISTURE
1000 HRTL FM FOR PRIOR 7 DAY PERIOD <COL 40>
0 8 16 24 32 40 48 56 64
CHANGE IN 1000 HRTL FM <COL 39>
10 9 8 7 6 5 4 3 2 1 0 -1 -2 -3 -4 -5 -6 -7 -8 -9 -10
AVE BNDRY VALUE FOR CURRENT 7 DAY PERIOD <COL 38>
0 10 20 30 40 50 60 70 80 90 100


WOODY FUEL MOISTURE
200
150
100
50
WOODY FUEL MOISTURE (PERCENT) <COL 41>
CLIMATE CLASS 1 4
WOODY FUEL MOISTURE IS 200 PERCENT WHEN THE 1000-HR. TL FM EXCEEDS 25 PERCENT.
0
4
8
12
16
20
24
28
32
36
1000 HOUR TIMELAG FUEL MOISTURE <COL 40>

# PERENNIAL HERBS AND FORBS



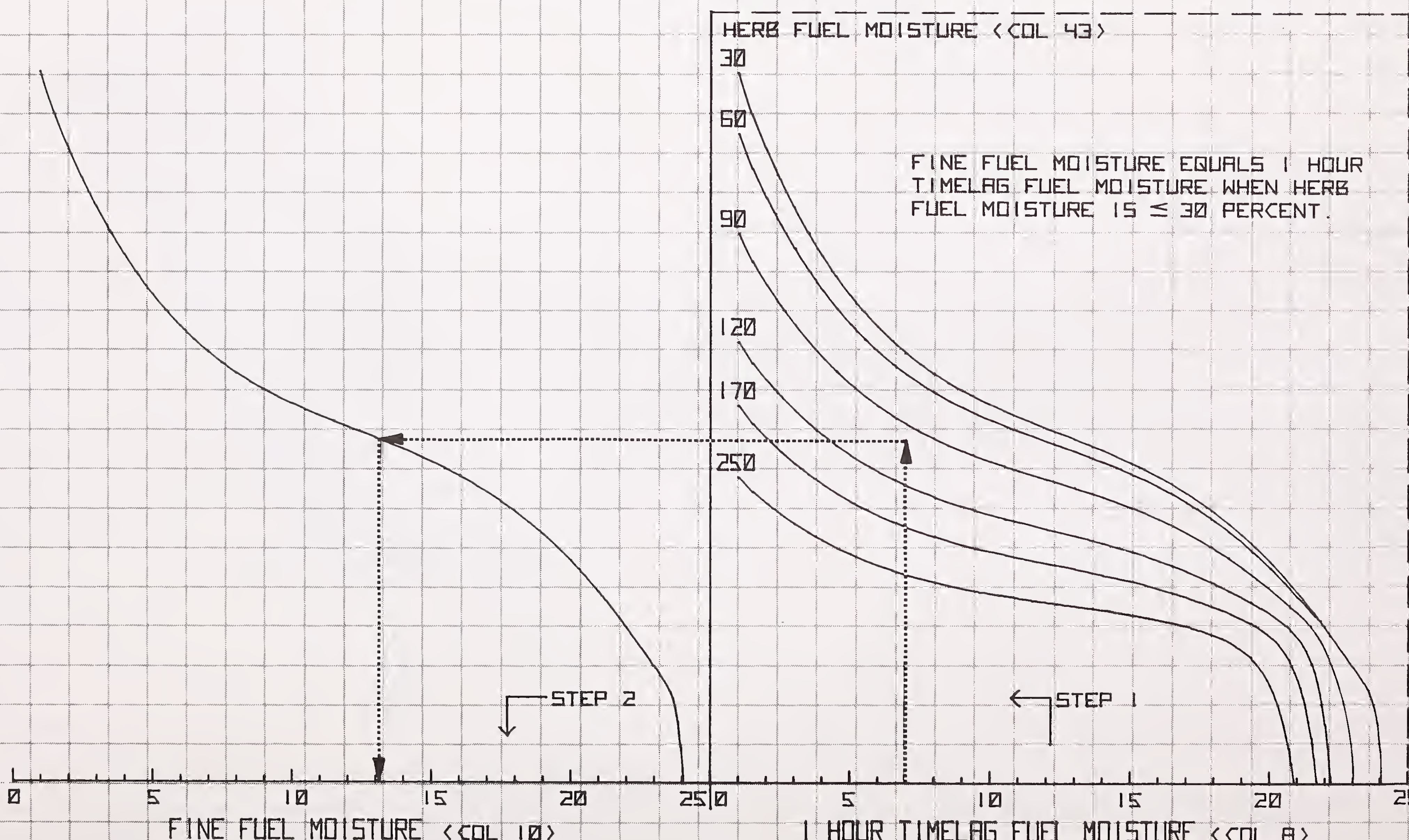

10 HOUR TIMELAG FUEL MOISTURE
AGE OF STICK (MONTHS)
5 3 1
0
0 5 10 15 20 25 30 35 40 45 50
OBSERVED FUEL STICK MOISTURE (PERCENT) (COL 6)
5 10 15 20 25 30 35 40 45 50
10 HOUR TIMELAG FUEL MOISTURE (COL 7)

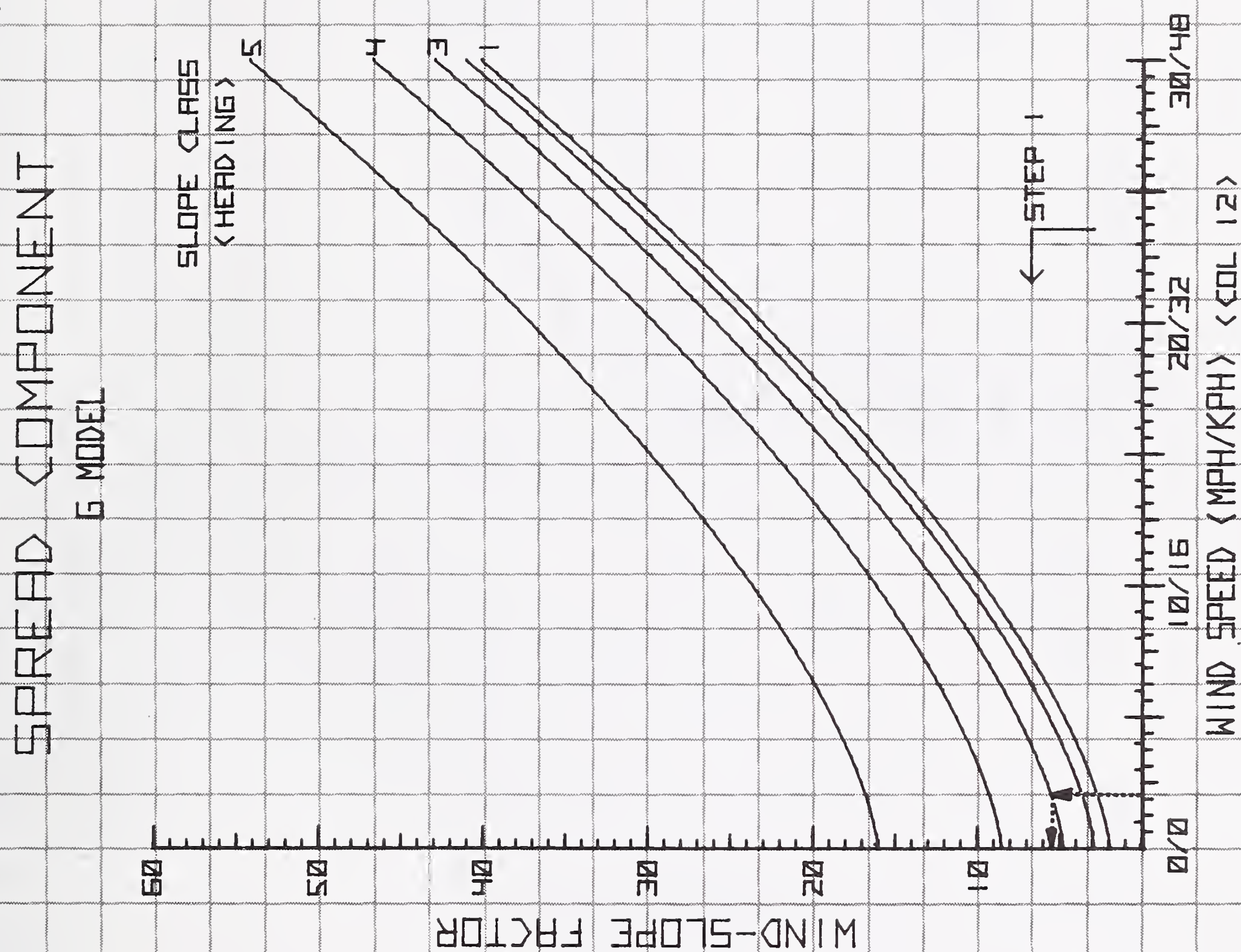


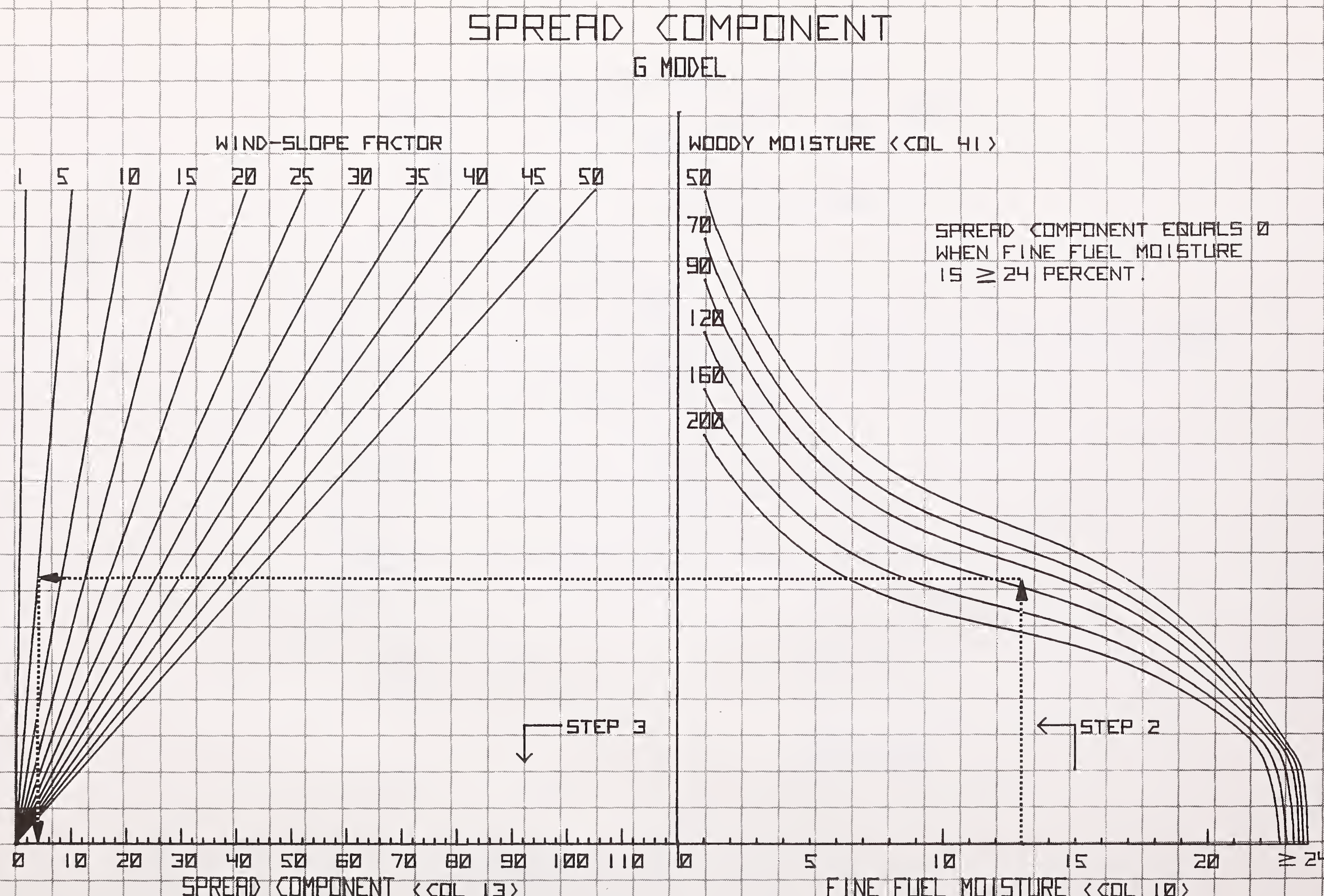
1 HOUR TIMELAG FUEL MOISTURE
10 HRTL FUEL MOISTURE <COL 7>
0 15 30 45 60 75
STATE OF WEATHER <COL 2>
3+
2
1
0
STEP 2
STEP 1
0 10 20 30 40
0 10 20 30 40 50 60 70 80 90 100
1 HOUR TIMELAG FUEL MOISTURE <COL 8>
OBS. TIME RELATIVE HUMIDITY <COL 5>

# FINE FUEL MOISTURE

## G MODEL

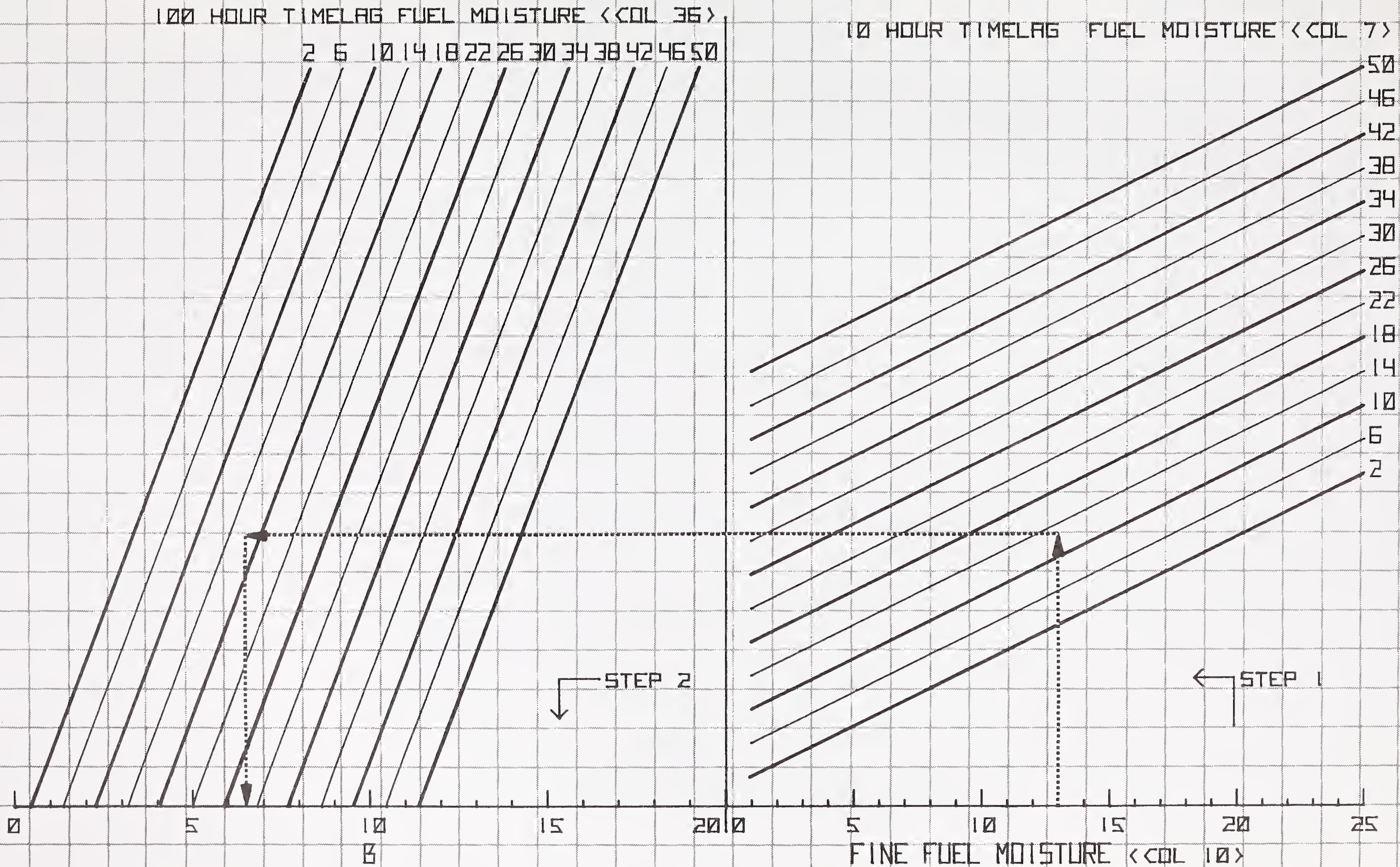


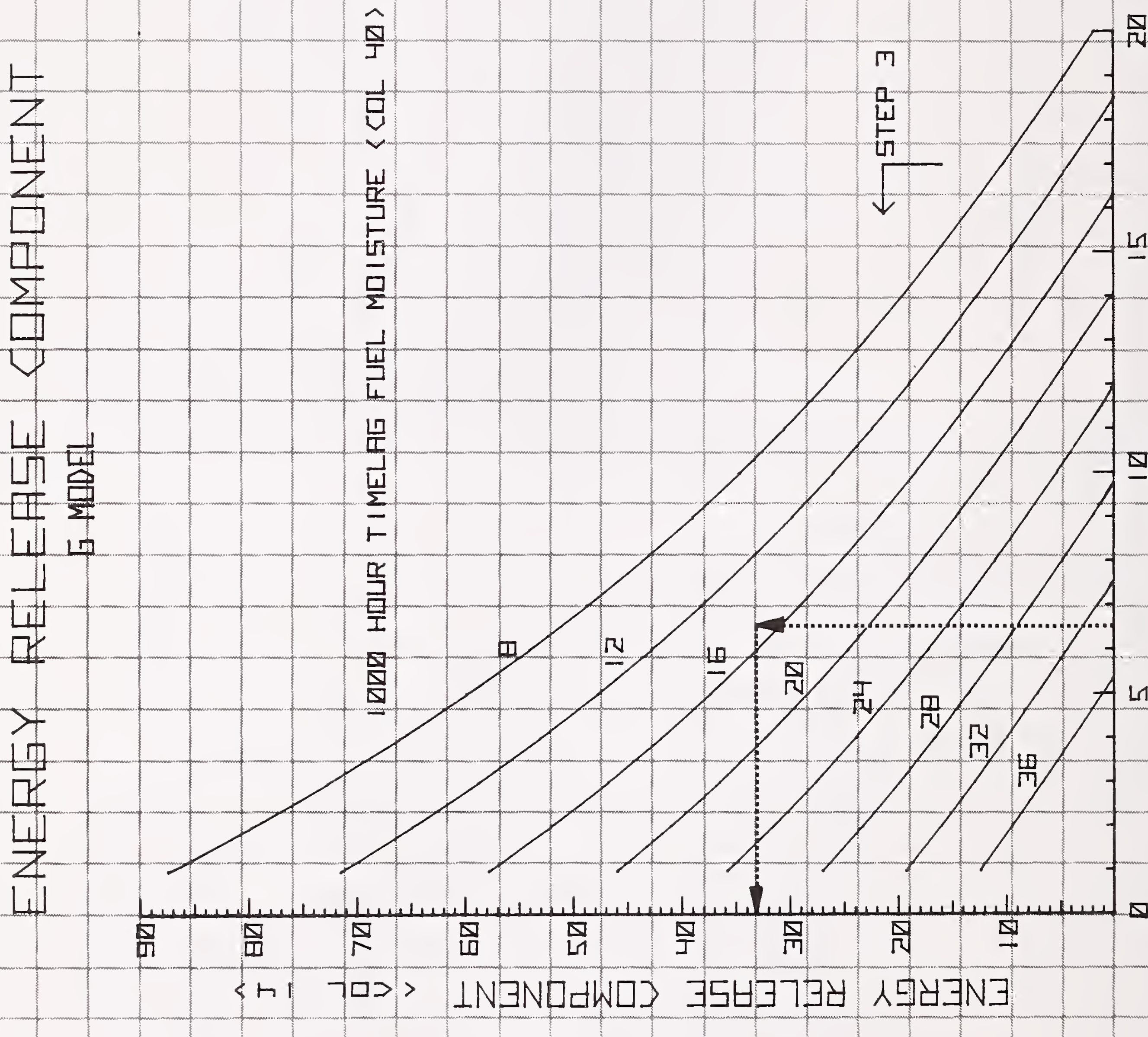

SPREAD COMPONENT
G MODEL
SLOPE CLASS
(HEADING)
5
4
3
1
STEP 1
WIND-SLOPE FACTOR
60
50
40
30
20
10
0/0
10/16
20/32
30/48
WIND SPEED (MPH/KPH) (COL 12)

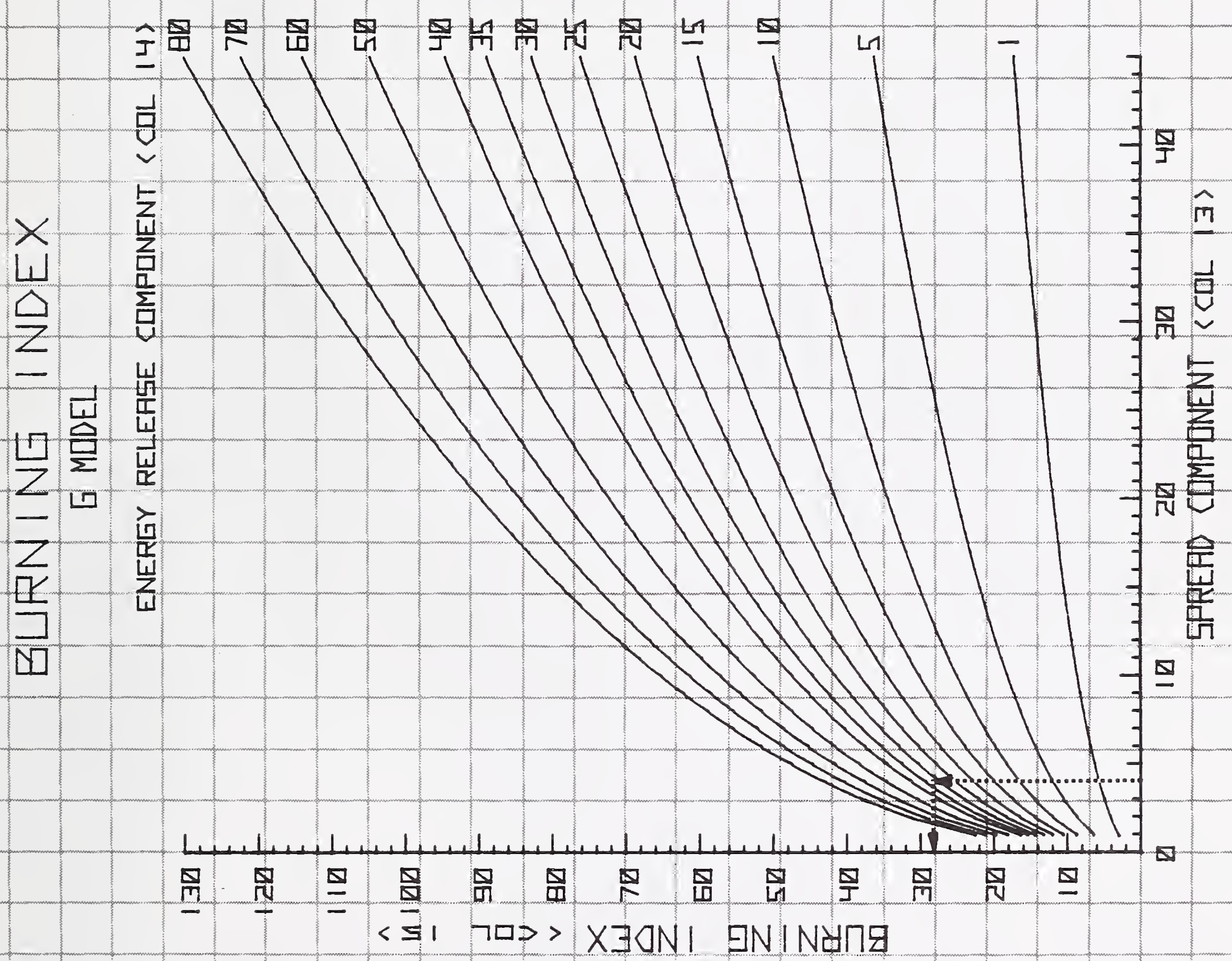

SPREAD COMPONENT
G MODEL
WIND-SLOPE FACTOR
1 5 10 15 20 25 30 35 40 45 50
WOODY MOISTURE <COL 41>
50 70 90 120 160 200
SPREAD COMPONENT EQUALS 0
WHEN FINE FUEL MOISTURE
IS ≥ 24 PERCENT.
STEP 3
STEP 2
0 10 20 30 40 50 60 70 80 90 100 110
SPREAD COMPONENT <COL 13>
0 5 10 15 20 ≥ 24
FINE FUEL MOISTURE <COL 10>

# ENERGY RELEASE COMPONENT

G MODEL

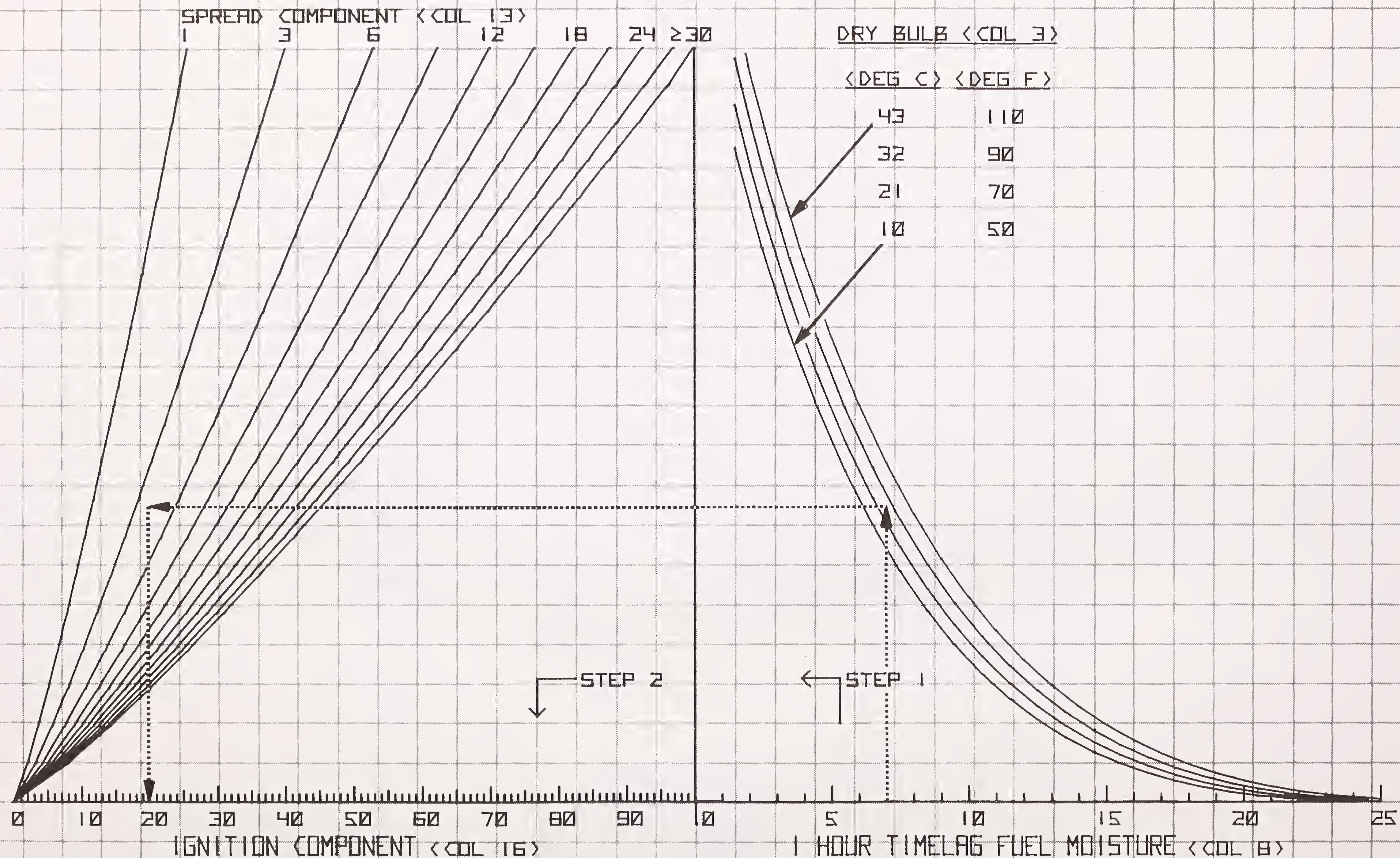



ENERGY RELEASE COMPONENT
G MODEL
1000 HOUR TIMELAG FUEL MOISTURE (COL 40)
STEP 3
8
12
16
20
24
28
32
36
0
5
10
B
15
20
ENERGY RELEASE COMPONENT (COL 14)
0
10
20
30
40
50
60
70
80
90

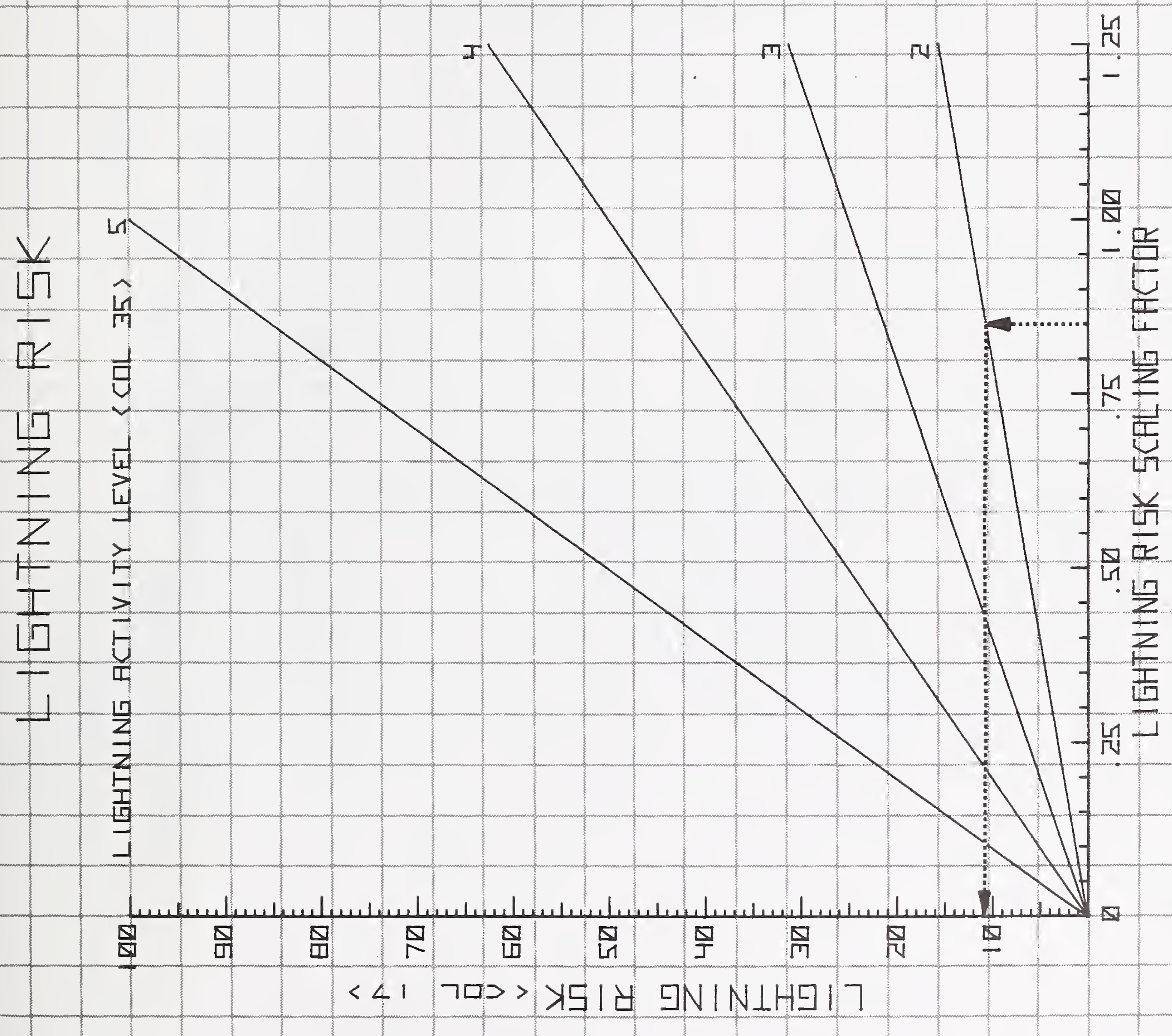

BURNING INDEX
G MODEL
ENERGY RELEASE COMPONENT (COL 14)
80
70
60
50
40
35
30
25
20
15
10
5
1
SPREAD COMPONENT (COL 13)
0
10
20
30
40
BURNING INDEX (COL 15)
10
20
30
40
50
60
70
80
90
100
110
120
130

# IGNITION COMPONENT*

G MODEL

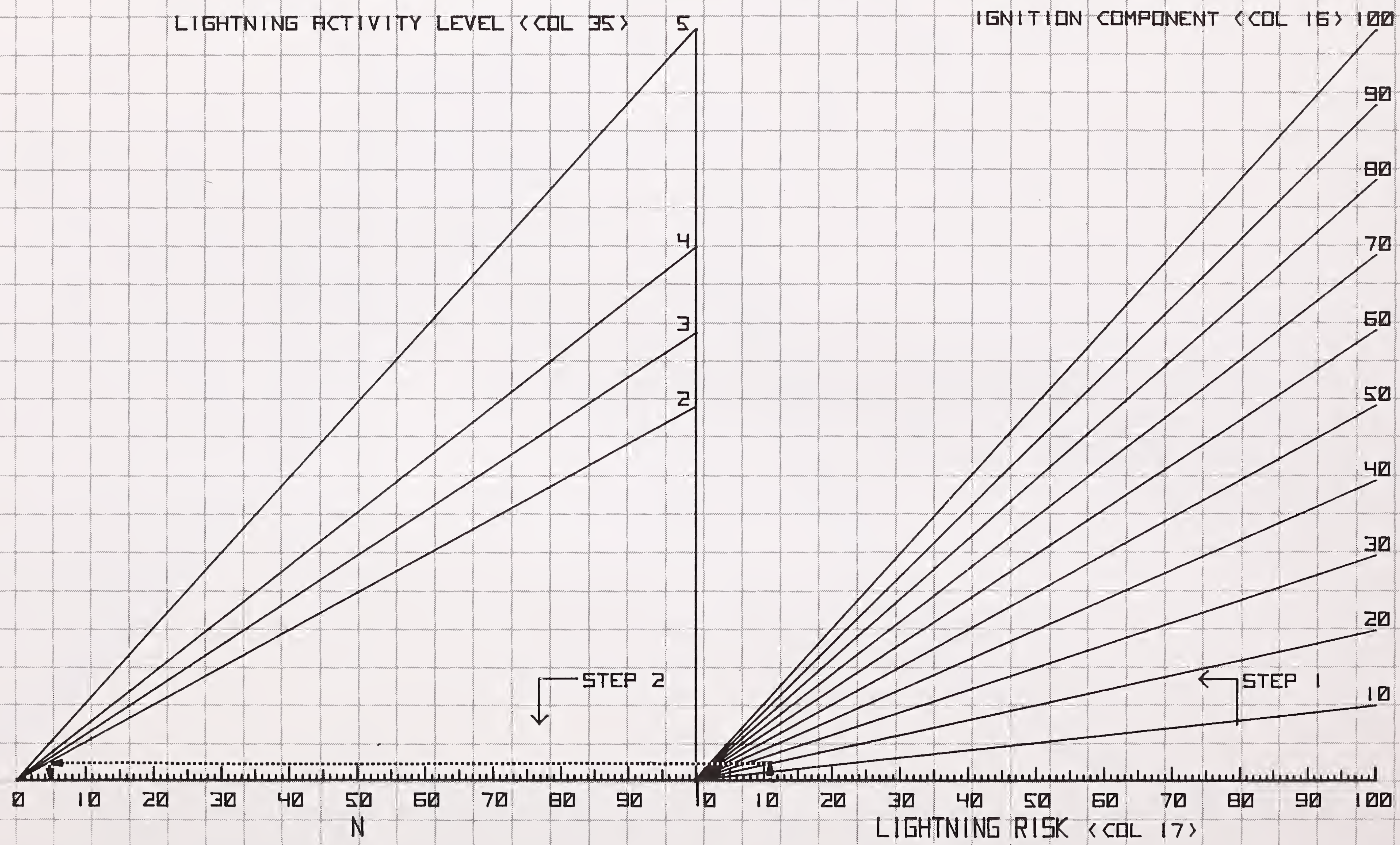


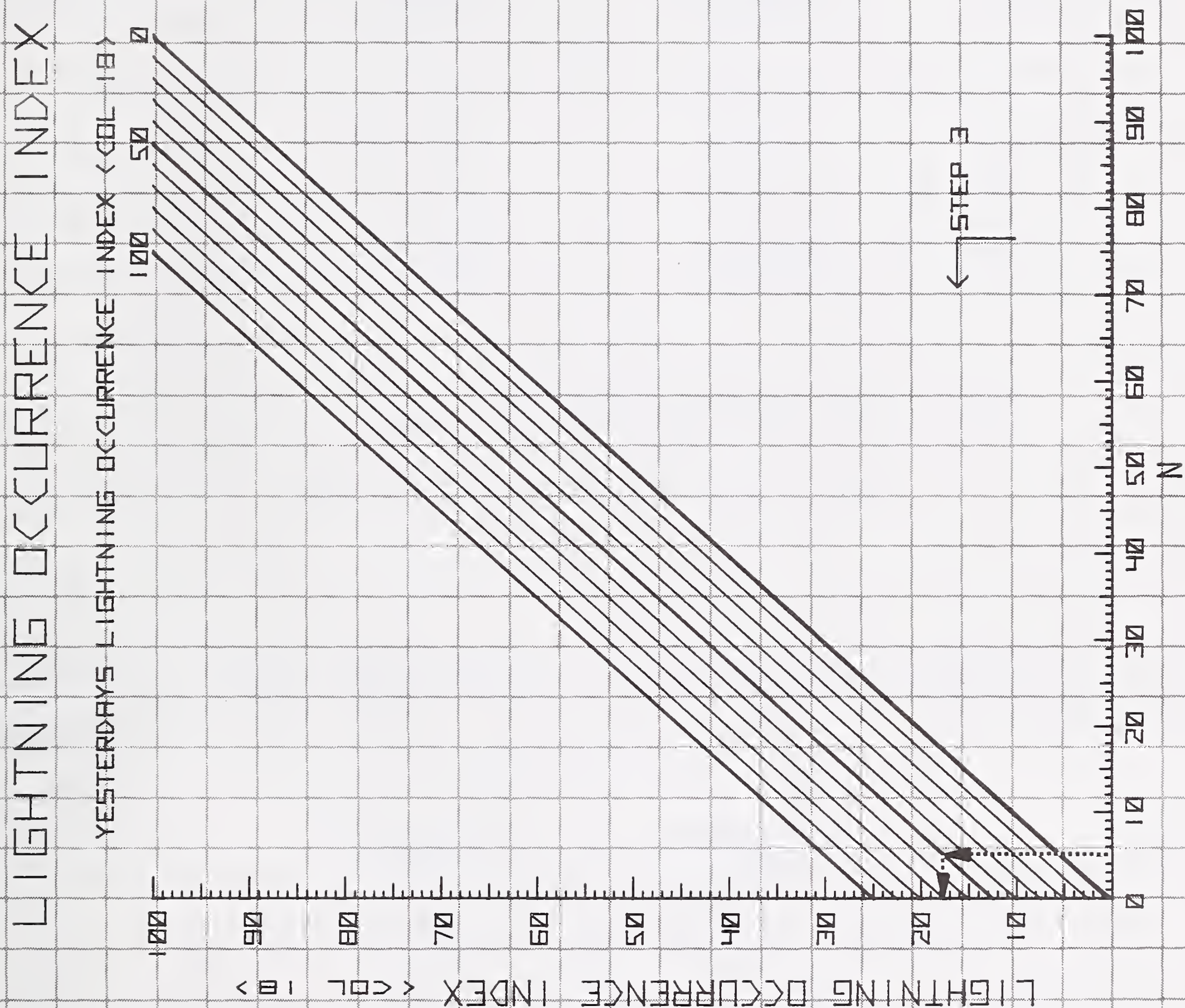

*THIS EXAMPLE IGNITION COMPONENT NOMOGRAM MAY DIFFER SLIGHTLY FROM THE G MODEL IC NOMOGRAM OBTAINED FROM BIFC.



LIGHTNING RISK
LIGHTNING ACTIVITY LEVEL (COL 35)
LIGHTNING RISK (COL 17)
LIGHTNING RISK SCALING FACTOR
0
10
20
30
40
50
60
70
80
90
100
.25
.50
.75
1.00
1.25
2
3
4
5

# LIGHTNING OCCURRENCE INDEX




LIGHTNING OCCURRENCE INDEX
YESTERDAYS LIGHTNING OCCURRENCE INDEX (COL 18)
0
50
100
STEP 3
0 10 20 30 40 50 60 70 80 90 100
N
100 90 80 70 60 50 40 30 20 10 0
LIGHTNING OCCURRENCE INDEX (COL 18)

MAN-CAUSED RISK COMPUTATION FORM

Unit LIBBY DISTRICT Date 7/1/75

MCR scaling factor .18 Day of week FRIDAY

| Risk source | Risk source ratio | Daily activity level | Partial risk (E-1) |
|---|---|---|---|
| 1. EQUIPMENT USE | 24 | NORMAL | 6 |
| 2. CAMPFIRES | 7 | NORMAL | 2 |
| 3. DEBRIS BURNING | 15 | NORMAL | 4 |
| 4. ALL OTHER | 8 | NORMAL | 2 |
| 5. | | | |

Total - Unnormalized MC RISK - - - - - - - - - - - - 14

MCR (E-2) - - - - - - - - - - - - - - - - - - 10

Unit LIBBY DISTRICT Date 7/2/75

MCR scaling factor .18 Day of week SATURDAY

| Risk source | Risk source ratio | Daily activity level | Partial risk (E-1) |
|---|---|---|---|
| 1. EQUIPMENT USE | 12 | NORMAL | 3 |
| 2. CAMPFIRES | 23 | HIGH | 12 |
| 3. DEBRIS BURNING | 30 | NORMAL | 7 |
| 4. ALL OTHER | 9 | NORMAL | 3 |
| 5. | | | |

Total - Unnormalized MC RISK - - - - - - - - - - - - 25

MCR (E-2) - - - - - - - - - - - - - - - - - - 19

MAN-CAUSED RISK COMPUTATION FORM

Unit LIBBY DISTRICT Date 7/3/75

MCR scaling factor .18 Day of week SUNDAY

| | Risk source | Risk source ratio | Daily activity level | Partial risk (E-1) |
|---|---|---|---|---|
| 1. | EQUIPMENT USE | 4 | NORMAL | |
| 2. | CAMPFIRES | 27 | HIGH | |
| 3. | DEBRIS BURNING | 19 | NORMAL | |
| 4. | ALL OTHER | 8 | NORMAL | |
| 5. | | | | |

Total - Unnormalized MC RISK - - - - - - - - - - - - - ________

MCR (E-2) - - - - - - - - - - - - - - - - - - - ________

Unit LIBBY DISTRICT Date 7/4/75

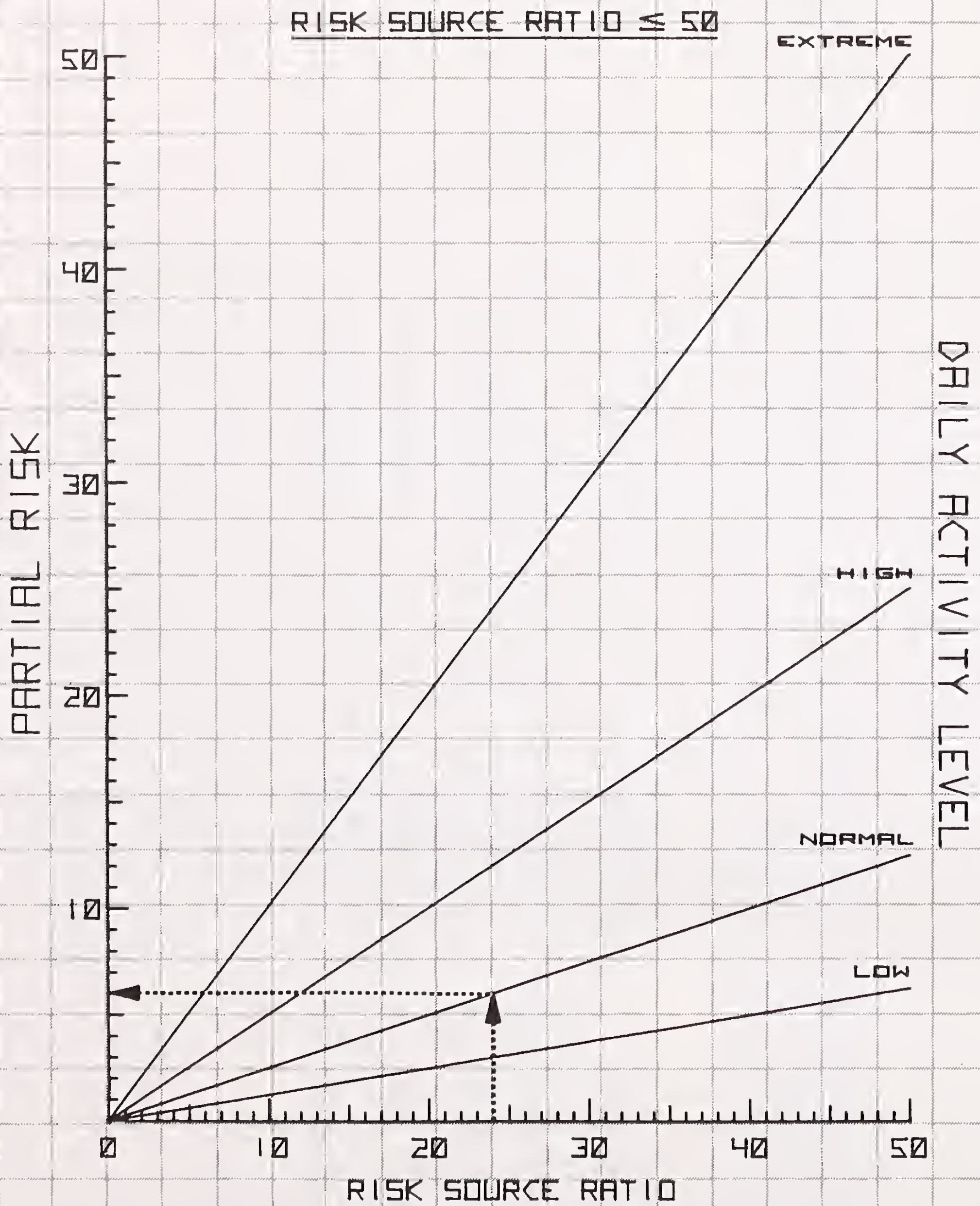
MCR scaling factor .18 Day of week MONDAY

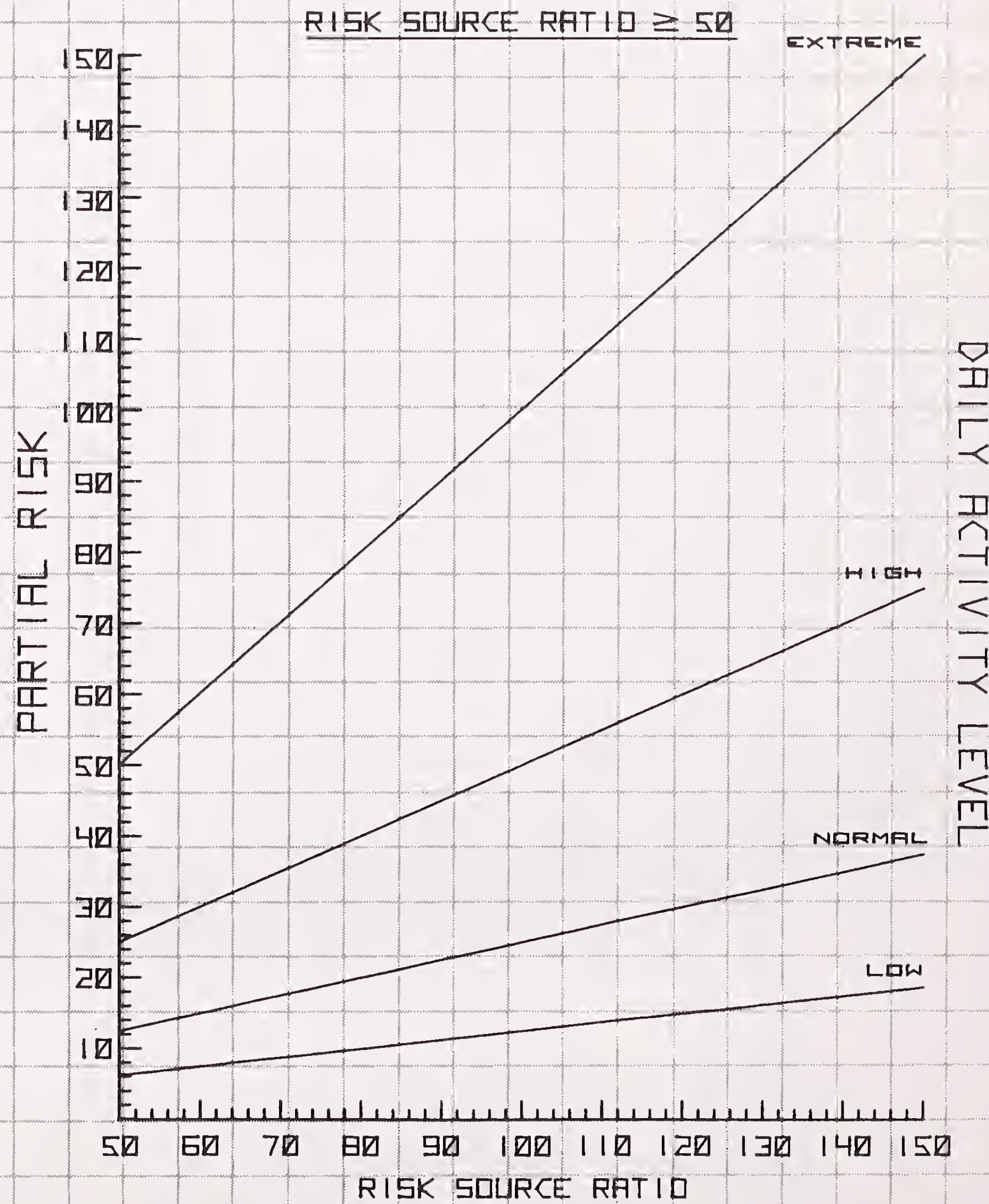
| | Risk source | Risk source ratio | Daily activity level | Partial risk (E-1) |
|---|---|---|---|---|
| 1. | EQUIPMENT USE | 26 | LOW | |
| 2. | CAMPFIRES | 6 | EXTREME | |
| 3. | DEBRIS BURNING | 18 | NORMAL | |
| 4. | ALL OTHER | 8 | NORMAL | |
| 5. | | | | |

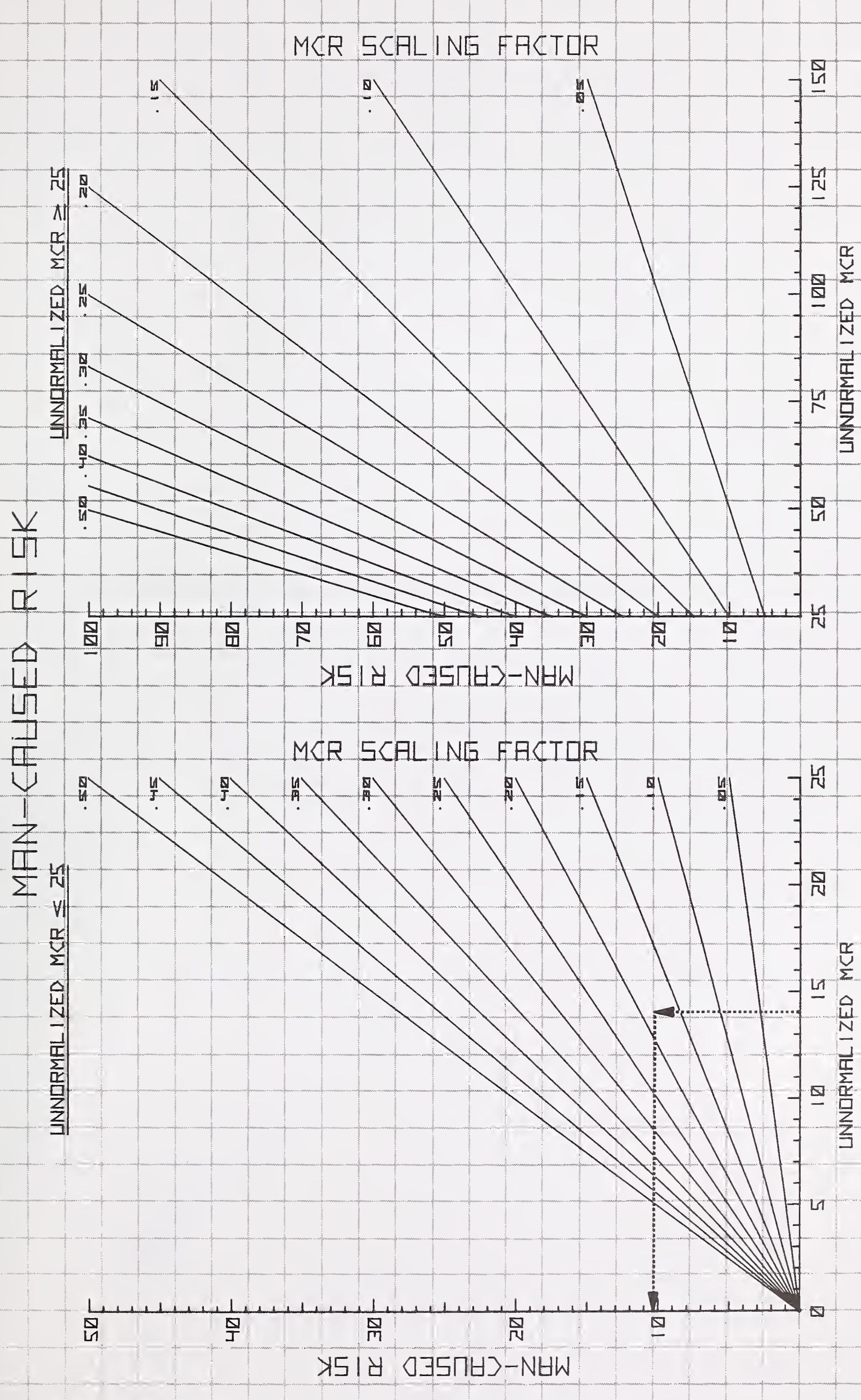
Total - Unnormalized MC RISK - - - - - - - - - - - - - ________

MCR (E-2) - - - - - - - - - - - - - - - - - - - ________

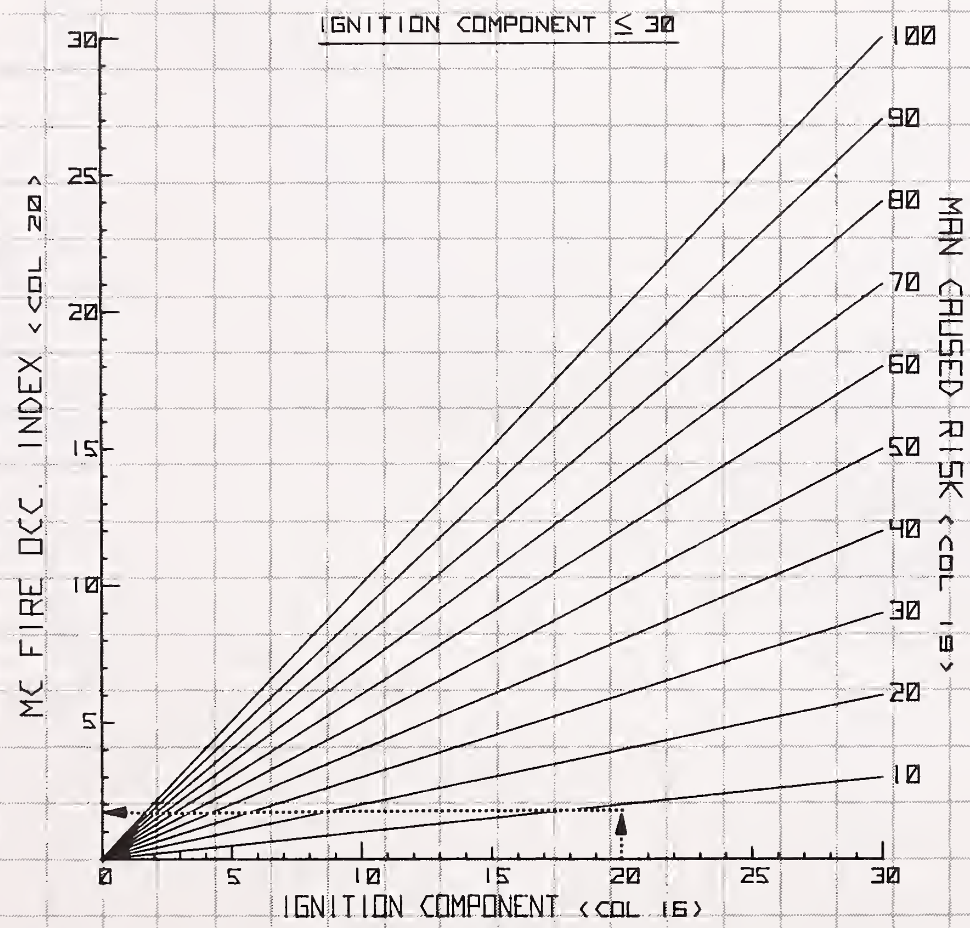
# PARTIAL RISK

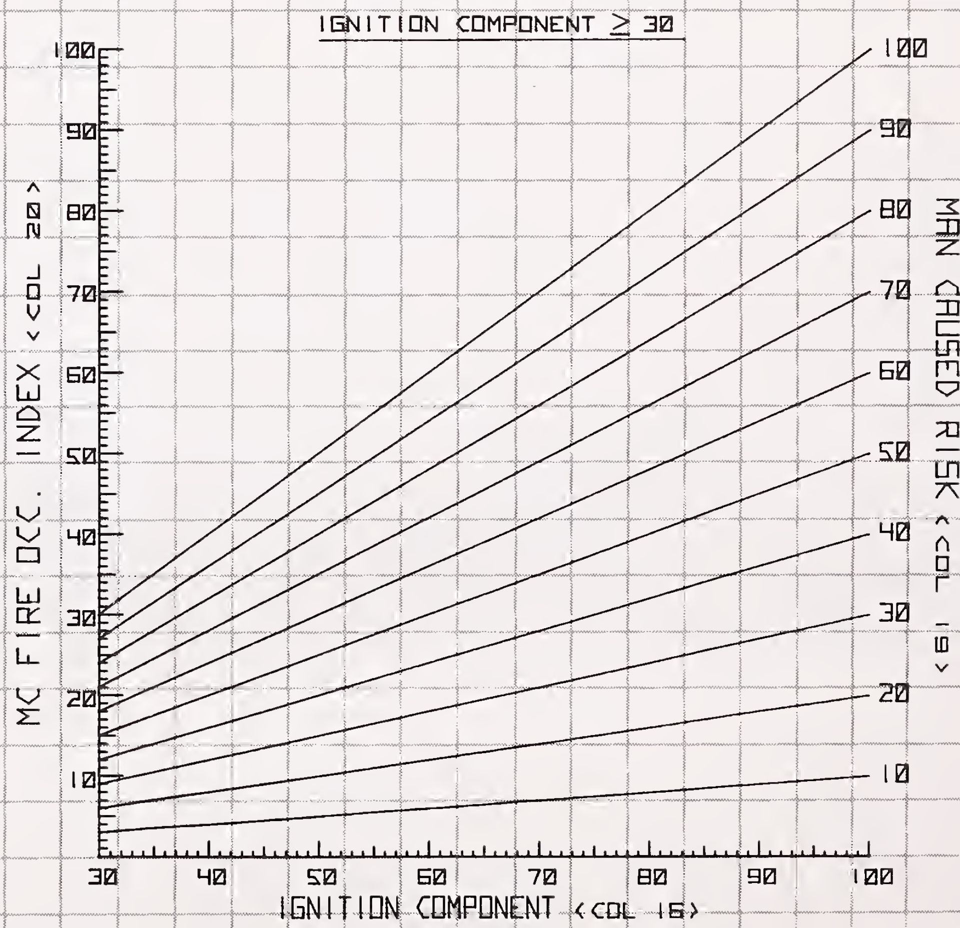


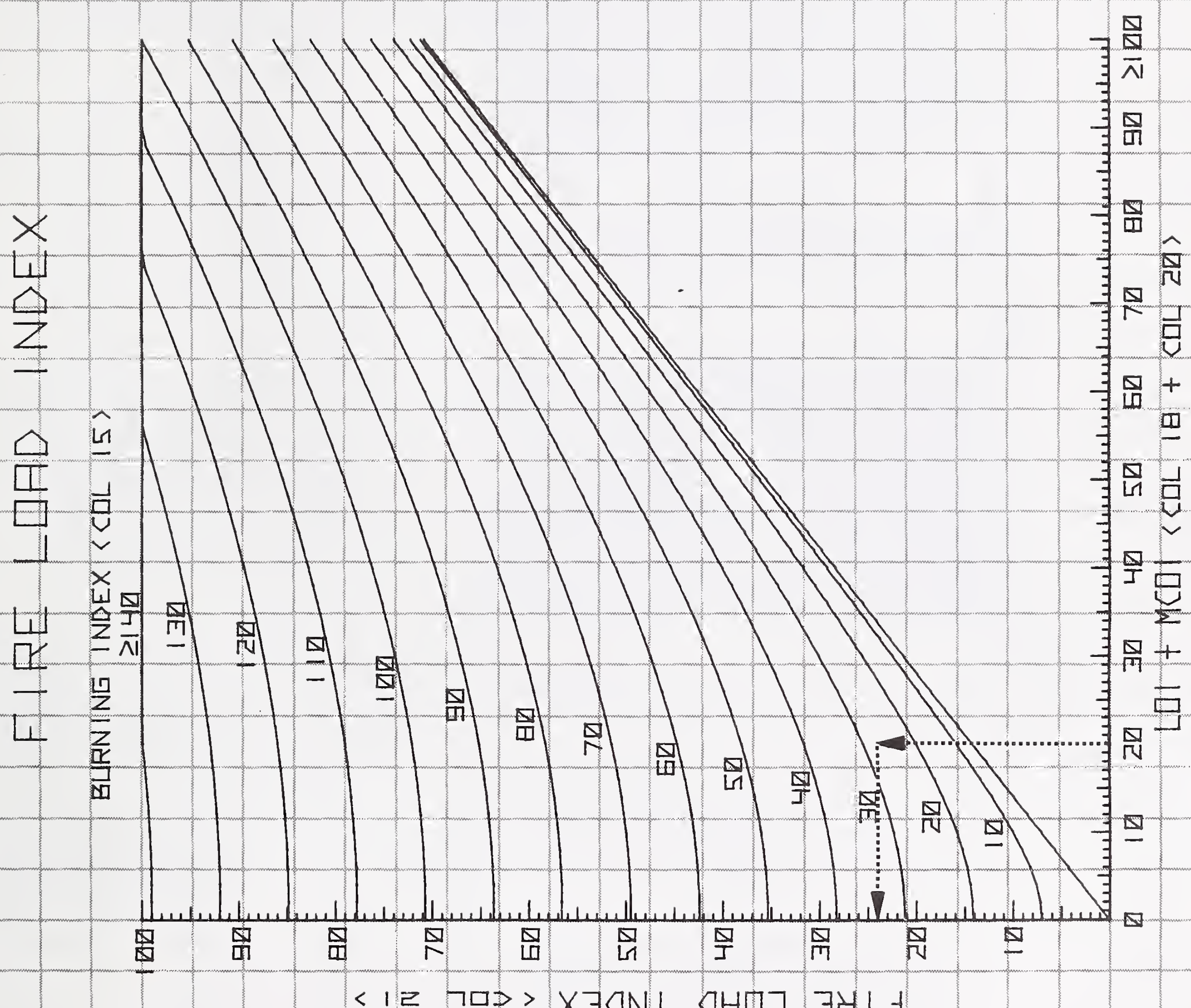




MAN-CAUSED RISK
UNNORMALIZED MCR ≥ 25
MCR SCALING FACTOR
UNNORMALIZED MCR
MAN-CAUSED RISK
UNNORMALIZED MCR ≤ 25
MCR SCALING FACTOR
UNNORMALIZED MCR
MAN-CAUSED RISK

# MAN-CAUSED FIRE OCCURRENCE INDEX




FIRE LOAD INDEX
BURNING INDEX <COL 15>
≥140
130
120
110
100
90
80
70
60
50
40
30
20
10
LOI + MCOI <COL 18 + COL 20>
FIRE LOAD INDEX <COL 21>

10 DAY
FIRE DANGER AND FIRE
WEATHER RECORD

| Agency | Unit | Station Name | Station Number |
|---|---|---|---|
| FOREST SERVICE | LIBBY DISTRICT | LIBBY | 240107 |

| Station Elevation | Fuel Model | ~~Annual or~~ Perennial | Slope Class | Climate Class | Basic Obs Time (LST) | Period of Record (Month, Day, Year) From | To |
|---|---|---|---|---|---|---|---|
| 2070 | G | P | 3 | 3 | 1400 | 7/1/75 | 7/10/75 |

Observer

Checked By

| Day of Month | State of Weather | Temperature: Dry Bulb | Temperature: Wet Bulb | Relative Humidity | Observed Fuel Sticks | 10-Hr TL Fuel Moisture | 1-Hr TL Fuel Moisture | Herb. Veg. Condition | Fine Fuel Moisture | Wind: Direction | Wind: Speed | Burning Index: Spread Component | Burning Index: Energy Release Component | Burning Index | Ignition Component | Occurrence Indexes: Lightning Risk | Lightning Occurrence Index | Man-caused Risk | Man-caused Occurrence Index | Fire Load Index | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | |
| 1 | 1 | 79 | | 39 | 10 | 13 | 7 | | 13 | | 2 | 4 | 33 | 28 | 20 | 11 | 18 | 10 | 2 | 24 | 1/2" FM STICKS |
| 2 | 2 | 81 | | 32 | 7 | 10 | 6 | | 12 | | 2 | 4 | 36 | 30 | 22 | 0 | 4 | 19 | 4 | 22 | ARE 3MOS. OLD |
| 3 | 3 | 69 | | 34 | 8 | 11 | 7 | | 13 | | 2 | 4 | 36 | 30 | 19 | 0 | 0 | 15 | 3 | 21 | |
| 4 | 6 | 55 | | 94 | 21 | 26 | 30+ | 98 | 30+ | | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 16 | 0 | 0 | |
| 5 | 3 | 61 | | 69 | 28 | 33 | 16 | | 19 | | 1 | 3 | 20 | 20 | 3 | 0 | 0 | 20 | 1 | 14 | |
| 6 | 3 | 64 | | 53 | 19 | 23 | 12 | | 17 | | 1 | 3 | 25 | 22 | 7 | 0 | 0 | 13 | 1 | 15 | |
| 7 | 1 | 72 | | 40 | 11 | 14 | 8 | | 15 | | 4 | 4 | 30 | 28 | 17 | 0 | 0 | 15 | 2 | 20 | |
| 8 | 0 | 78 | | 41 | 9 | 12 | 7 | | 15 | | 2 | 3 | 26 | 23 | 18 | 43 | 11 | 12 | 2 | 24 | RECALCULATE 1000-HR |
| 9 | 6 | 52 | | 100 | 21 | 26 | 30+ | 98 | 30+ | | 2 | 0 | 0 | 0 | 0 | 11 | 3 | 23 | 0 | 0 | |
| 0 | 3 | 57 | | 67 | 26 | 31 | 16 | | 19 | | 3 | 3 | 16 | 18 | 3 | 11 | 2 | 25 | 1 | 13 | |
| 31 | | | | | | | | | | | | | | | | | | | | | |

Daily (24 Hour) Data

| Day of Month | Temperature: Maximum | Temperature: Minimum | Relative Humidities: Maximum | Relative Humidities: Minimum | Relative Humidities: Average | Precipitation: Kind | Precipitation: Began | Precipitation: Ended | Precipitation: Duration | Precipitation: Amount | Lightning: Began | Lightning: Ended | Lightning: Activity Level | 100-Hr TL Fuel Moisture | 1000-Hr TL Fuel Moisture: Today s 1000-Hr Bndry Value | Average 7 Day Bndry Value | Change 1000-Hr Fuel Moisutre | 1000-Hr TL Fuel Moisture | Living Fuel Moistures: Woody Fuel Moisture | X1000 Moisture Value | Herb Fuel Moisture | A | B | C | D |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 | 31 | 32 | 33 | 34 | 35 | 36 | 37 | 38 | 39 | 40 | 41 | 42 | 43 | A | B | C | D |
| 1 | 79 | 44 | 99 | 39 | 69 | | | | 0 | | | | 2 | 16 | 14 | 17 | +1 | 15 | 110 | 14 | 100 | | | | |
| 2 | 82 | 40 | 90 | 22 | 56 | | | | 0 | | | | 1 | 14 | 11 | - | - | 15 | 110 | 14 | 100 | | | | |
| 3 | 84 | 44 | 99 | 20 | 60 | | | | 0 | | | | 1 | 13 | 12 | - | - | 15 | 110 | 14 | 100 | | | | |
| 4 | 69 | 48 | 99 | 30 | 65 | 5 | 0500 | 1300 | 8 | .16 | | | 1 | 16 | 41 | - | - | 15 | 110 | 14 | 100 | | | | |
| 5 | 61 | 45 | 99 | 69 | 84 | 5 | 0200 | 1200 | 10 | .32 | | | 1 | 20 | 54 | - | - | 15 | 110 | 14 | 100 | | | | |
| 6 | 66 | 46 | 99 | 52 | 76 | 5 | 1600 | 1800 | 2 | .05 | | | 1 | 19 | 22 | - | - | 15 | 110 | 14 | 100 | | | | |
| 7 | 72 | 47 | 99 | 40 | 70 | 6 | 0800 | 0900 | 1 | .04 | | | 1 | 18 | 17 | - | - | 15 | 110 | 14 | 100 | | | | |
| 8 | 78 | 45 | 99 | 40 | 70 | | | | 0 | | | | 4 | 17 | 14 | 24 | +3 | 18 | 140 | 16 | 110 | | | | |
| 9 | 85 | 52 | 99 | 32 | 66 | 6 | 1300 | 1800 | 5 | .29 | | | 2 | 18 | 29 | - | - | 18 | 140 | 16 | 110 | | | | |
| 0 | 76 | 42 | 99 | 67 | 83 | 6 | 1600 | 1800 | 2 | .12 | | | 2 | 19 | 24 | - | - | 18 | 140 | 16 | 110 | | | | |
| 31 | | | | | | | | | | | | | | | | | | | | | | | | | |

MAN-CAUSED RISK COMPUTATION FORM

Unit LIBBY DISTRICT Date 7/3/75

MCR scaling factor .18 Day of week SUNDAY

| Risk source | Risk source ratio | Daily activity level | Partial risk (E-1) |
|---|---|---|---|
| 1. EQUIPMENT USE | 4 | NORMAL | 1 |
| 2. CAMPFIRES | 27 | HIGH | 13 |
| 3. DEBRIS BURNING | 19 | NORMAL | 5 |
| 4. ALL OTHER | 8 | NORMAL | 2 |
| 5. | | | |

Total - Unnormalized MC RISK - - - - - - - - - - - - - 21

MCR (E-2) - - - - - - - - - - - - - - - - - - - - 15

Unit LIBBY DISTRICT Date 7/4/75

MCR scaling factor .18 Day of week MONDAY

| Risk source | Risk source ratio | Daily activity level | Partial risk (E-1) |
|---|---|---|---|
| 1. EQUIPMENT USE | 26 | LOW | 3 |
| 2. CAMPFIRES | 12 | EXTREME | 12 |
| 3. DEBRIS BURNING | 18 | NORMAL | 5 |
| 4. ALL OTHER | 8 | NORMAL | 2 |
| 5. | | | |

Total - Unnormalized MC RISK - - - - - - - - - - - - - 22

MCR (E-2) - - - - - - - - - - - - - - - - - - - - 16

# PUBLICATIONS CITED

Cramer, Owen P.
1961. Predicting moisture contents of fuel moisture indicator sticks in the Pacific Northwest. USDA For. Serv. Res. Pap. PNW-41, 17 p. Pac. Northwest For. and Range Exp. Stn., Portland, Oreg.

Deeming, John E., J. W. Lancaster, M. A. Fosberg, R. W. Furman, and M. J. Schroeder.
1972. The National Fire-Danger Rating System. USDA For. Serv. Res. Pap. RM-84, 165 p. Rocky Mt. For. and Range Exp. Stn., Fort Collins, Colo. Revised 1974.

Deeming, John E., Robert E. Burgan, and Jack D. Cohen.
1977. The National Fire-Danger Rating System--1978. USDA For. Serv. Gen. Tech. Rep. INT-39, 63 p. Intermt. For. and Range Exp. Stn., Ogden, Utah.

Furman, R. William, and Glen E. Brink.
1975. The National Fire-Weather Library: what is it and how to use it. USDA For. Serv. Gen. Tech. Rep. RM-19, 8 p. Rocky Mt. For. and Range Exp. Stn., Fort Collins, Colo.

Helfman, Robert S., John E. Deeming, Robert J. Straub, and R. William Furman.
1975. Users guide to AFFIRMS: time-share computerized processing for fire danger rating. USDA For. Serv. Gen. Tech. Rep. RM-15, 107 p. Rocky Mt. For. and Range Exp. Stn., Fort Collins, Colo.

# APPENDIX A

## ESTIMATING THE MAXIMUM AND MINIMUM RELATIVE HUMIDITIES

If your station is equipped with a properly adjusted and maintained hygrothermograph, the maximum and minimum RH for the 24-hour period ending at your basic observation time is already available. However, if only wet-dry bulb and maximum-miniumum temperatures are available, the following procedure must be used to estimate the 24-hour maximum and minimum relative humidities:

1. 24-Hour Maximum Relative Humidity

    a. If frost or dew was observed on vegetation (not on glass or metal) or if precipitation or fog was observed during the preceding 24 hours, assume the maximum RH to be 100 percent.

    b. If no frost, dew, precipitation, or fog was observed, the maximum RH must be estimated. First, compute the dew point at today's basic observation time (record in column A). Read the estimated 24-hour maximum RH from the accompanying table (page 44) at the intersection of the row indexed by the 24-hour minimum temperature and the column indexed by the dew point. *The value recorded should not be less than either yesterday's or today's basic observation time relative humidities.*

2. 24-Hour Minimum Relative Humidity

    From the accompanying table (page 44), read the 24-hour minimum RH at the intersection of the row indexed by the 24-hour maximum temperature and the column indexed by today's dew point. *The computed minimum RH should not be greater than either yesterday's or today's basic observation time relative humidity.*

**24-HOUR MAXIMUM (MINIMUM) RELATIVE HUMIDITY (PERCENT)**
**Col. 25 (Col. 26)**

DEW POINT (°F) Col. 4

| 24-HOUR MINIMUM (MAXIMUM) TEMPERATURE °F COL. 24 (COL. 23) | -15→-12 | -11→-8 | -7→-4 | -3→0 | 1→4 | 5→8 | 9→12 | 13→16 | 17→20 | 21→24 | 25→28 | 29→32 | 33→36 | 37→40 | 41→44 | 45→48 | 49→52 | 53→56 | 57→60 | 61→64 | 65→68 | 69→72 | 73→76 | 77→80 | 81→84 | 85→88 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1→4 | 46 | 56 | 68 | 83 | 100 | | | | | | | | | | | | | | | | | | | | | |
| 5→8 | 38 | 47 | 57 | 69 | 83 | 100 | | | | | | | | | | | | | | | | | | | | |
| 9→12 | 32 | 39 | 48 | 58 | 69 | 84 | 100 | | | | | | | | | | | | | | | | | | | |
| 13→16 | 27 | 33 | 40 | 48 | 58 | 70 | 84 | 100 | | | | | | | | | | | | | | | | | | |
| 17→20 | 23 | 28 | 33 | 41 | 49 | 59 | 70 | 84 | 100 | | | | | | | | | | | | | | | | | |
| 21→24 | 19 | 23 | 28 | 34 | 41 | 50 | 59 | 71 | 84 | 100 | | | | | | | | | | | | | | | | |
| 25→28 | 16 | 20 | 24 | 29 | 35 | 42 | 50 | 60 | 71 | 85 | 100 | | | | | | | | | | | | | | | |
| 29→32 | 14 | 17 | 20 | 25 | 30 | 36 | 43 | 51 | 61 | 72 | 85 | 100 | | | | | | | | | | | | | | |
| 33→36 | 12 | 14 | 17 | 21 | 25 | 30 | 36 | 43 | 52 | 61 | 72 | 85 | 100 | | | | | | | | | | | | | |
| 37→40 | 10 | 12 | 15 | 18 | 22 | 26 | 31 | 37 | 44 | 52 | 62 | 73 | 85 | 100 | | | | | | | | | | | | |
| 41→44 | 9 | 10 | 13 | 15 | 18 | 22 | 27 | 32 | 38 | 45 | 53 | 62 | 73 | 86 | 100 | | | | | | | | | | | |
| 45→48 | 7 | 9 | 11 | 13 | 16 | 19 | 23 | 27 | 32 | 38 | 45 | 53 | 63 | 73 | 86 | 100 | | | | | | | | | | |
| 49→52 | 6 | 8 | 9 | 11 | 14 | 16 | 20 | 23 | 28 | 33 | 39 | 46 | 54 | 63 | 74 | 86 | 100 | | | | | | | | | |
| 53→56 | 5 | 6 | 8 | 10 | 12 | 14 | 17 | 20 | 24 | 28 | 34 | 40 | 47 | 55 | 64 | 74 | 86 | 100 | | | | | | | | |
| 57→60 | 5 | 6 | 7 | 8 | 10 | 12 | 15 | 17 | 21 | 25 | 29 | 34 | 40 | 47 | 55 | 64 | 75 | 87 | 100 | | | | | | | |
| 61→64 | 4 | 5 | 6 | 7 | 9 | 11 | 13 | 15 | 19 | 21 | 25 | 30 | 35 | 41 | 48 | 56 | 65 | 75 | 87 | 100 | | | | | | |
| 65→68 | 4 | 4 | 5 | 6 | 8 | 9 | 11 | 13 | 16 | 19 | 22 | 26 | 30 | 36 | 42 | 48 | 56 | 65 | 75 | 87 | 100 | | | | | |
| 69→72 | 3 | 4 | 5 | 6 | 7 | 8 | 10 | 11 | 14 | 16 | 19 | 23 | 26 | 31 | 36 | 42 | 49 | 57 | 66 | 76 | 87 | 100 | | | | |
| 73→76 | 3 | 3 | 4 | 5 | 6 | 7 | 8 | 10 | 12 | 14 | 17 | 20 | 23 | 27 | 32 | 37 | 43 | 50 | 57 | 66 | 76 | 87 | 100 | | | |
| 77→80 | 2 | 3 | 4 | 4 | 5 | 6 | 7 | 9 | 10 | 12 | 15 | 17 | 20 | 24 | 28 | 32 | 38 | 44 | 50 | 58 | 67 | 77 | 88 | 100 | | |
| 81→84 | 2 | 3 | 3 | 4 | 5 | 5 | 6 | 8 | 9 | 11 | 13 | 15 | 18 | 21 | 24 | 28 | 33 | 38 | 44 | 51 | 59 | 67 | 77 | 88 | 100 | |
| 85→88 | 2 | 2 | 3 | 3 | 4 | 5 | 5 | 7 | 8 | 10 | 11 | 13 | 16 | 18 | 21 | 25 | 29 | 34 | 39 | 45 | 51 | 60 | 68 | 77 | 88 | 100 |
| 89→92 | 2 | 2 | 2 | 3 | 4 | 4 | 5 | 6 | 7 | 8 | 10 | 12 | 14 | 16 | 19 | 22 | 26 | 30 | 34 | 39 | 45 | 52 | 60 | 68 | 78 | 88 |
| 93→96 | 1 | 2 | 2 | 3 | 3 | 4 | 4 | 5 | 6 | 7 | 9 | 10 | 12 | 14 | 17 | 19 | 23 | 26 | 30 | 35 | 40 | 46 | 53 | 60 | 68 | 78 |
| 97→100 | 1 | 2 | 2 | 2 | 3 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 11 | 13 | 15 | 17 | 20 | 23 | 27 | 31 | 35 | 41 | 47 | 53 | 61 | 69 |
| 101→104 | 1 | 1 | 2 | 2 | 2 | 3 | 3 | 4 | 5 | 6 | 7 | 8 | 10 | 11 | 13 | 15 | 18 | 21 | 24 | 27 | 31 | 36 | 41 | 47 | 54 | 61 |
| 105→108 | 1 | 1 | 1 | 2 | 2 | 3 | 3 | 4 | 4 | 5 | 6 | 7 | 9 | 10 | 12 | 14 | 16 | 18 | 21 | 24 | 28 | 32 | 37 | 42 | 48 | 54 |
| 109→112 | 1 | 1 | 1 | 2 | 2 | 2 | 3 | 3 | 4 | 5 | 5 | 6 | 8 | 9 | 10 | 12 | 14 | 16 | 19 | 22 | 25 | 29 | 33 | 37 | 43 | 48 |
| 113→116 | 1 | 1 | 1 | 1 | 2 | 2 | 2 | 3 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 11 | 13 | 14 | 17 | 19 | 22 | 25 | 29 | 33 | 38 | 43 |
| 117→120 | 1 | 1 | 1 | 1 | 2 | 2 | 2 | 3 | 3 | 4 | 4 | 5 | 6 | 7 | 8 | 10 | 11 | 13 | 15 | 17 | 20 | 23 | 26 | 30 | 34 | 39 |

Example

The 24-hour maximum and minimum temperatures, 87° F. and 61° F; dry-bulb and wet-bulb temperatures at Basic Observation Time, 83° F. and 65° F. Using the 23-inch psychrometric tables, the RH and dewpoint at Basic Observation Time are 41 percent and 57° F. From the accompanying table the 24-hour maximum RH is 87 percent; the 24-hour minimum RH is 39 percent.

# APPENDIX B

## ESTIMATING THE 10-HOUR TIMELAG FUEL MOISTURE

These nomograms (pages 46, 47) can be used (1) for predicting the next day's 10-h TL FM, and (2) for estimating the current day's 10-h TL FM if fuel moisture sticks are not used.

A specific example will illustrate the procedure:

*EXAMPLE:*

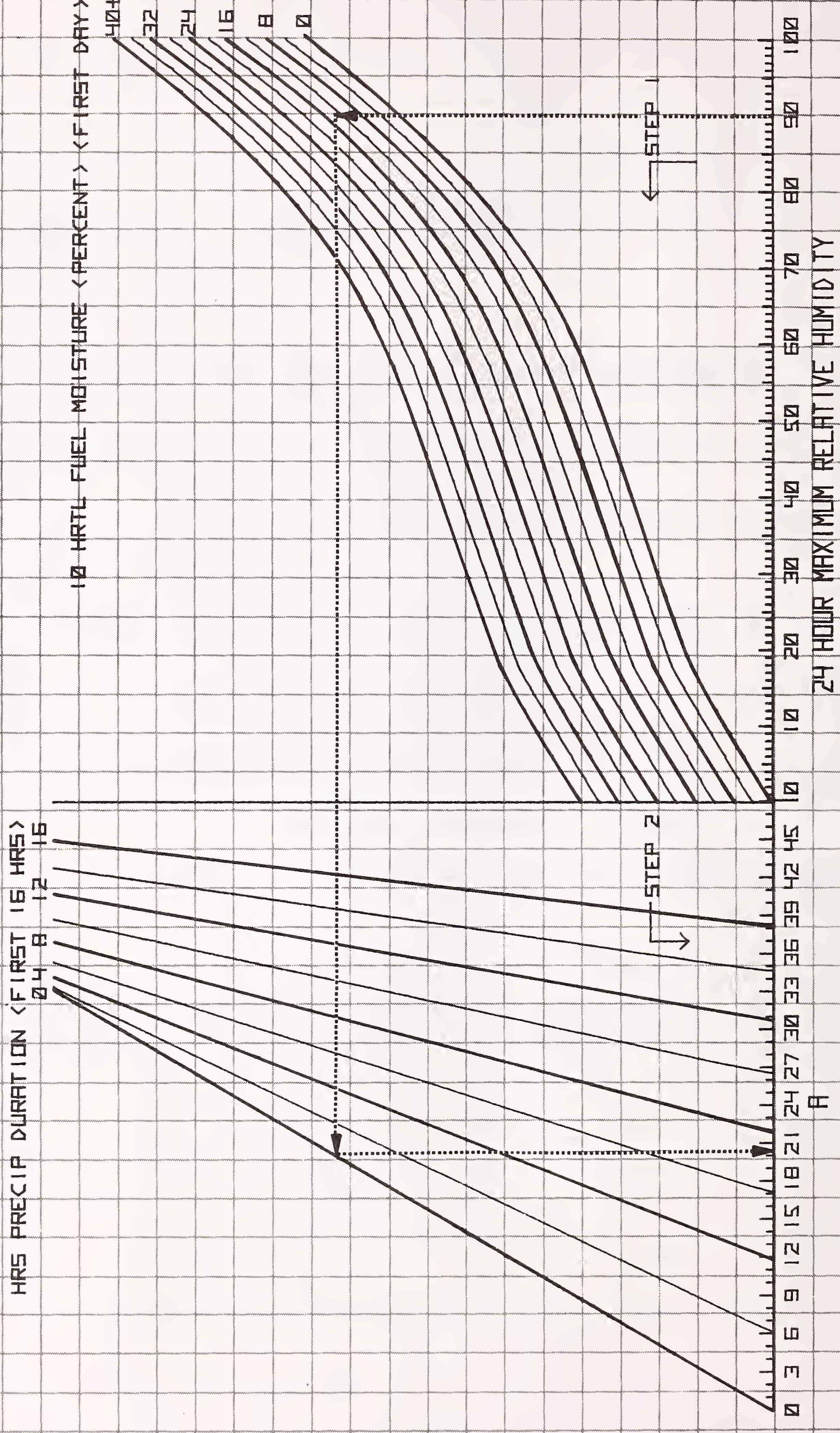
What is the predicted 10-h TL FM at basic observation time tomorrow?

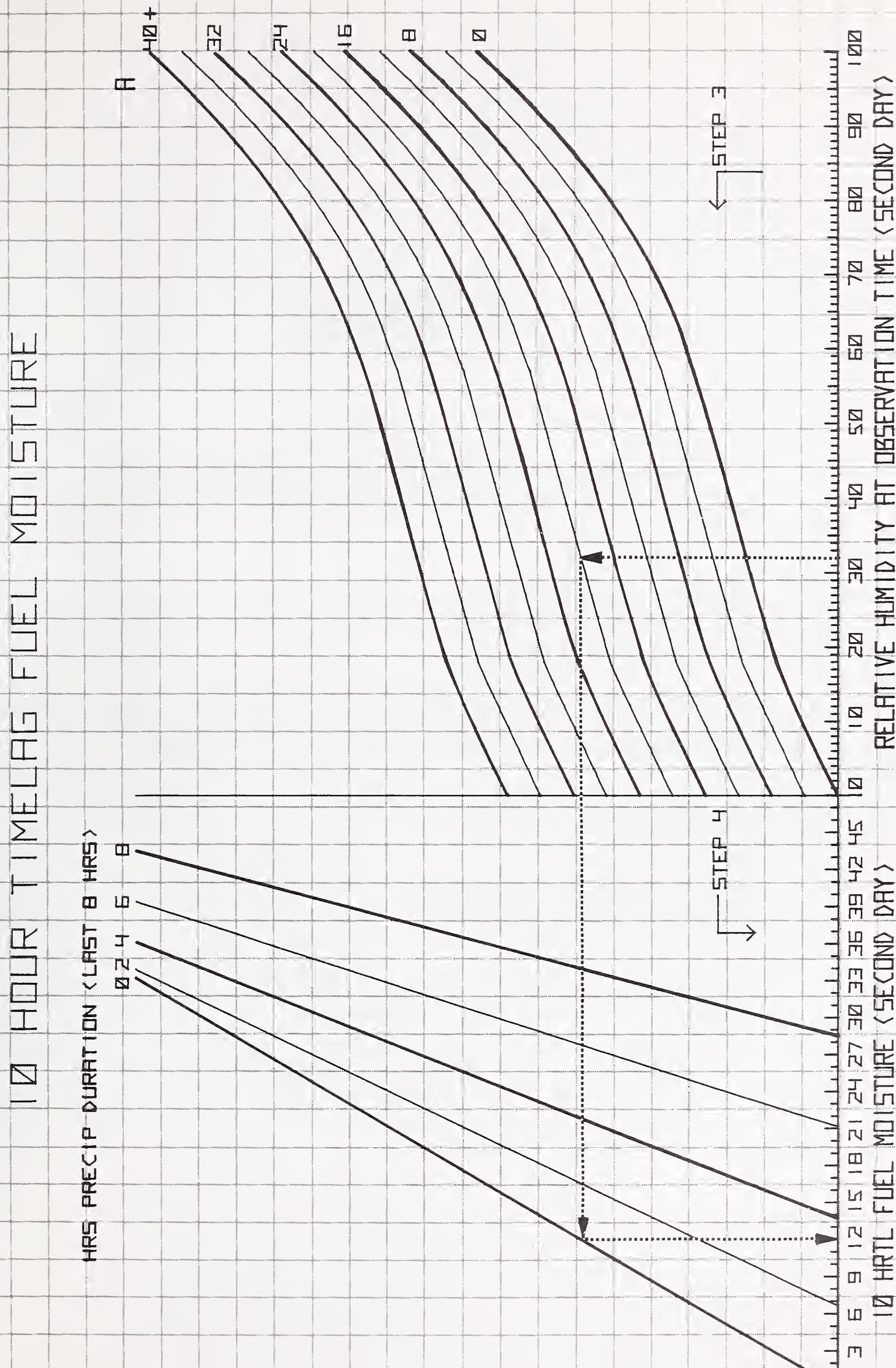
85 percent -- 24-hour maximum relative humidity.
8 percent -- 10-h TL FM at basic observation time today.
2 hours -- Forecasted precipitation duration for the 16-hour period starting at basic observation time today.
15 percent -- Forecasted relative humidity at basic observation time tomorrow.
0 hours -- Forecasted precipitation duration for the 8 hours preceding tomorrow's basic observation time.

The arrows trace the procedure through nomogram. Notice that "A," the result from step 2, is used to select from the family of curves in step 3; it is *not* entered on the x-axis.

If a satisfactory procedure for predicting the 10-h TL FM is currently available in your area or region, it is not necessary to use the procedure presented here. Simpler, empirical techniques, such as the one developed by Cramer (1961), may prove more accurate for local use. The NFDRS method is meant for general application; hence its complexity.

# 10 HOUR TIMELAG FUEL MOISTURE




10 HOUR TIMELAG FUEL MOISTURE
HRS PRECIP DURATION <LAST 8 HRS>
0 2 4 6 8
A
40+
32
24
16
8
0
STEP 3
STEP 4
0 3 6 9 12 15 18 21 24 27 30 33 36 39 42 45
10 HRTL FUEL MOISTURE <SECOND DAY>
0 10 20 30 40 50 60 70 80 90 100
RELATIVE HUMIDITY AT OBSERVATION TIME <SECOND DAY>

# APPENDIX C

## PUNCHCARD FORMAT FOR USE WITH THE 10-DAY FIRE DANGER AND FIRE WEATHER RECORD

This card format was designed for use with the revised 10-Day Fire Danger and Fire Weather Record proposed for use with the 1978 NFDRS. It was assumed that the 10-day record will be used as the source document.

The format published in RM-84 (Deeming and others 1972) should continue to be used with the WS Form D-9A. For identification purposes, the RM-84 format should be referenced as the "1972 format," and the following as the "1978 format."

For punched data to be included in the National Fire Weather Library (Furman and Brink 1975), send cards to:

NFDR Liaison
Boise Interagency Fire Center
3905 Vista Avenue
Boise, Idaho 83705

Notice that only observed data are punched. The computer will recalculate fuel moistures, components, and indexes when needed.

If, and ONLY if, the woody fuel moisture or the dead fuel moisture contents (1-, 10-, and 100-h TL) are observed are these values to be punched. For instance, if the 10-h TL FM is determined from the fuel sticks, it should be punched; if it is estimated, leave card columns 20, 21, and 22 blank.

PUNCHCARD FORMAT 10-DAY FIRE DANGER AND FIRE WEATHER RECORD

| Field No.[1] | Heading | Columns From | Columns To | Columns No. of | Remarks [2] |
|---|---|---|---|---|---|
| | Station number | 1 | 6 | 6 | Heading |
| | Year | 7 | 8 | 2 | Heading |
| | Month | 9 | 10 | 2 | Heading |
| 1 | Day | 11 | 12 | 2 | |
| 2 | State of weather | | 13 | 1 | |
| 3 | Dry bulb temperature | 14 | 16 | 3 | If negative, put -- in column 14. |
| 4 | Humidity variable [3] | 17 | 19 | 3 | If negative, put -- in column 17 (see Humidity Variable Identifier.) |
| 7 | 10-h TL FM [4] | 20 | 22 | 3 | Analog values only. |
| 8 | 1-h TL FM [4] | 23 | 25 | 3 | Analog or stick values only. |
| 9 | Herb. Veg. Condition | 26 | 27 | 2 | Enter G, C, or F for greenup, curing, or freezing, respectively. Enter on the day of occurrence only. |
| 11 | Wind direction | | 28 | 1 | 8 pt. compass. |
| 12 | Windspeed | 29 | 31 | 3 | |
| 19 | Man-caused risk | 32 | 34 | 3 | |
| 23 | 24-hour maximum temperature | 35 | 37 | 3 | If negative, put -- in column 35. |
| 24 | 24-hour minimum temperature | 38 | 40 | 3 | If negative, put -- in column 38. |
| 25 | 24-hour maximum RH | 41 | 43 | 3 | |
| 26 | 24-hour minimum RH | 44 | 46 | 3 | |
| 28 | Precipitation kind | | 47 | 1 | |
| 31 | Precipitation duration | 48 | 49 | 2 | During previous 24 hours; nearest whole hour. |
| 32 | Precipitation amount | 50 | 53 | 4 | Two decimal places; for trace, enter T. |
| 35 | Lightning activity level | 54 | 56 | 3 | |
| 36 | 100-h TL FM [4] | 57 | 59 | 3 | Analog values only. |
| 41 | Woody fuel moisture [4] | 60 | 62 | 3 | |
| | Humidity variable identifier | | 63 | 1 | Enter a 1 for wet bulb; 2 for relative humidity; or a 3 for dew point. |
| | Format identifier | 79 | 80 | 2 | Enter 78. |

[1] From the 10-Day Fire and Weather Record.
[2] If no data, leave field blank.
[3] Wet bulb, relative humidity, or dew point.
[4] Entered only when data from fuel moisture sticks or other kinds of analogs are available; otherwise leave blank.

NFDR LIAISON
Boise Interagency Fire Center
3905 Vista Avenue
Boise, Idaho 83705

Please send the following NFDRS nomograms to:

______________________________

______________________________

______________________________

Type 1 and 2 nomograms

| | | | | |
|---|---|---|---|---|
| | ____ A | ____ F | ____ K | ____ Q |
| | ____ B | ____ G | ____ L | ____ R |
| ____ Sets | ____ C | ____ H | ____ N | ____ S |
| | ____ D | ____ I | ____ O | ____ T |
| | ____ E | ____ J | ____ P | ____ U |

Nomogram Order Blank

Order one set of type 1 and 2 nomograms for each fire weather station and one set of type 3 nomograms for each fuel model to be used at each fire weather station. Enter number desired in the appropriate blanks.

Burgan, Robert E., Jack D. Cohen, and John E. Deeming.
1977. Manually calculating fire-danger ratings--1978 National Fire-Danger Rating System. USDA For. Serv. Gen. Tech. Rep. INT-40, 51 p. Intermt. For. and Range Exp. Stn., Ogden, Utah 84401.

This publication contains instructions for manually calculating the indexes and components of the 1978 National Fire-Danger Rating System (NFDRS). The procedures are explained with worked examples. Working sets of nomograms for the 20 NFDRS fuel models are not included. However, an order form for obtaining the needed nomograms is provided.

USDA Forest Service General Technical Report INT-39, The National Fire-Danger Rating System--1978 by John E. Deeming, Robert E. Burgan, and Jack D. Cohen, a companion publication, covers the NFDRS background, applications, and general principles of the system.

KEYWORDS: fire-danger rating, danger rating meters, burning index, fuel moisture content, lightning, man-caused fires, fire weather.

Burgan, Robert E., Jack D. Cohen, and John E. Deeming.
1977. Manually calculating fire-danger ratings--1978 National Fire-Danger Rating System. USDA For. Serv. Gen. Tech. Rep. INT-40, 51 p. Intermt. For. and Range Exp. Stn., Ogden, Utah 84401.

This publication contains instructions for manually calculating the indexes and components of the 1978 National Fire-Danger Rating System (NFDRS). The procedures are explained with worked examples. Working sets of nomograms for the 20 NFDRS fuel models are not included. However, an order form for obtaining the needed nomograms is provided.

USDA Forest Service General Technical Report INT-39, The National Fire-Danger Rating System--1978 by John E. Deeming, Robert E. Burgan, and Jack D. Cohen, a companion publication, covers the NFDRS background, applications, and general principles of the system.

KEYWORDS: fire-danger rating, danger rating meters, burning index, fuel moisture content, lightning, man-caused fires, fire weather.

☆ U.S. GOVERNMENT PRINTING OFFICE: 1977-0-777-023/36

NATIONAL
FIRE-DANGER
RATING SYSTEM